

THE DESIGN AND PRELIMINARY TESTING OF A
MECHANIZATION TRAINING PROGRAM FOR TRAINEES
WITH LOW LEVELS OF EDUCATION

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CERNYW KENNETH KLINE
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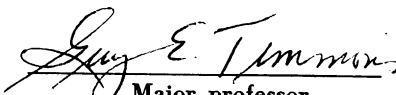


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ABSTRACT

THE DESIGN AND PRELIMINARY TESTING OF A MECHANIZATION TRAINING PROGRAM FOR TRAINEES WITH LOW LEVELS OF EDUCATION

By

Cernyw Kenneth Kline

The objective of this research study has been to plan, design, produce and pretest a machinery operator's training program tailored to meet the special needs of trainees with low levels of education and/or non-mechanical backgrounds. The resulting Basic Tractor Operators' Course used the systems engineering approach to create a modified structured learning and training environment (SLATE) to increase the effectiveness of training. It emphasizes cross-cultural transfer of advanced technology in the shortest possible time with minimum cost.

To serve the many machines in the job cluster of machine operators, a universal format was developed around the 50 to 100 horsepower diesel-engine agricultural wheel tractor. The possible generalization of this course to fit other machines was kept in mind during the development. The Basic Tractor Operators' Course for Grade I operators,



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minimally qualified, is built around measurable behavioral objectives, information for trainees, practical trainee exercises, suggested visual aids and teaching techniques. The 65 lessons of the course form the basis of an Instructor's Manual developed to guide instructors in teaching the BTOC.

The BTOC was field-tested with Spanish-speaking adult migrant trainees of Puerto Rican and Mexican descent in central Michigan. The course was conducted half-time over an eight-weeks' period from April to June, 1970. Using a one-to-four instructor-to-trainee ratio in small group training activities, the course stressed "hands on" learning with instruction individualized to meet trainees' needs. Of the 12 migrants completing the program, ten--or 83 per cent--were certified as qualified Basic Tractor Operators, Grade I.

Further testing is needed to validate the course design and training format in actual cross-cultural conditions with their unique constraints. Based upon the preliminary test with migrant laborers, the belief is that this type of performance training is applicable overseas and that it will result in a superior type of training with significantly less time and cost.

One of the most important lessons learned during the Michigan trial was that instructors, no matter how well they might appear to be qualified, must be trained

to work across cultural boundaries with disadvantaged trainees. A special training program was then developed to aid teachers in effectively using the "Instructor's Manual" as a guide and basic resource. This study has helped in developing a training program which can make instructors more effective and trainees more responsive.

THE DESIGN AND PRELIMINARY TESTING OF A MECHANIZATION
TRAINING PROGRAM FOR TRAINEES WITH LOW
LEVELS OF EDUCATION

By

Cernyw Kenneth Kline

A THESIS

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Department of Secondary Education and Curriculum

1970

PREFACE

Attention is called to the method of footnoting used in this thesis. A newly advocated system has been used which makes scientific literature easier to read and comprehend. Each time a reference is quoted, the individual or source is mentioned and the name and date, or the date only, is placed in parentheses within the text. No footnotes are used at the bottom of the pages except for explanation or identification of a non-published source of information.

As an example, in quoting Barnes, Kenneth K., "The Quality Machine Operator," Implement and Tractor, Vol. 85, No. 6; March 7, 1970; p. 18, the notation "Barnes (1970) says that . . ." or "According to an industry spokesman (Barnes, 1970), all operators of modern tractors require . . ." is fitted into the flowing text for the reader's information. When a long direct quote is made, the page number in parentheses is inserted in the text immediately before the quote as on Page 21. In short quotes within the text, the page number may be included with the date after the author's name such as, "Maddison (1964, pp. 4-5) asserts that some African countries"



The complete reference for each quotation is given in the alphabetized bibliography at the end of Chapter VI. To find out more about a specific source the reader should turn to the Bibliography on page 310 and look for the proper name and date of the reference. The system used eliminates numerous footnotes and such terms as "Op. Cit." and "Ibid." Since some personal communications and interviews are quoted, they have been included in the bibliography in alphabetical order.

It should also be noted that only one of the 65 lessons developed for the Basic Tractor Operators' Course (BTOC) is described completely in this thesis. A few sections of two other lessons are used to show some variations in the design and concept used to teach attitudes, skills, and knowledge (ASK) to trainees with low levels of education. Items in the appendix are only partially complete and are included to illustrate the type of approach taken in developing and implementing the BTOC. The complete course for the Basic Tractor Operator, Grade I, and associated training program materials are on file with Deere and Company, Moline, Illinois; with the Agricultural Engineering Department, Michigan State University, East Lansing, Michigan; or with the writer. A universal course could be developed for the basic agricultural diesel-powered wheel-tractor, for the gasoline and LP-gas-powered units, and for other machines if the demand warrants.

Much interest has been expressed in the Basic Tractor Operators' Course and the training program developed in this study. It is hoped that this specific course can be made available in printed form within the next few years for the use of interested persons, groups, or governments.

FOREWORD

During the past twelve years--five of which were spent overseas working on problems of developing countries--the writer has become more and more convinced that the crucial issue retarding societal growth is manpower development. No matter what view is considered, the problem is defined eventually as an educational one in which individuals must be taught how to do something. All of the planners' dreams and the politicians' promises are empty schemes unless they can be transformed into fact by skilled and willing human workers. Poets and philosophers have their place in inspiring the minds and the hearts of men, but it is able and calloused hands along with fretted and perspiring brows that fashion the physical materials and energy conversion systems that harness nature's power for man's benefit.

As the gap widens between the "have" and "have not" nations, and among the classes within them, the urgency of balancing manpower potential and aspirations becomes increasingly critical. The problem is not simply seeking new answers to increase the world's knowledge stockpile (which can be done by only a relatively few people), but one of more effectively applying what is already known and



available to benefit all of mankind. Much adaptive research is needed to fit the technology from the more developed nations to the needs and unique conditions of each developing country. The main limitation is the lack of application of known basic knowledge and science to the physical and emotional needs of human society.

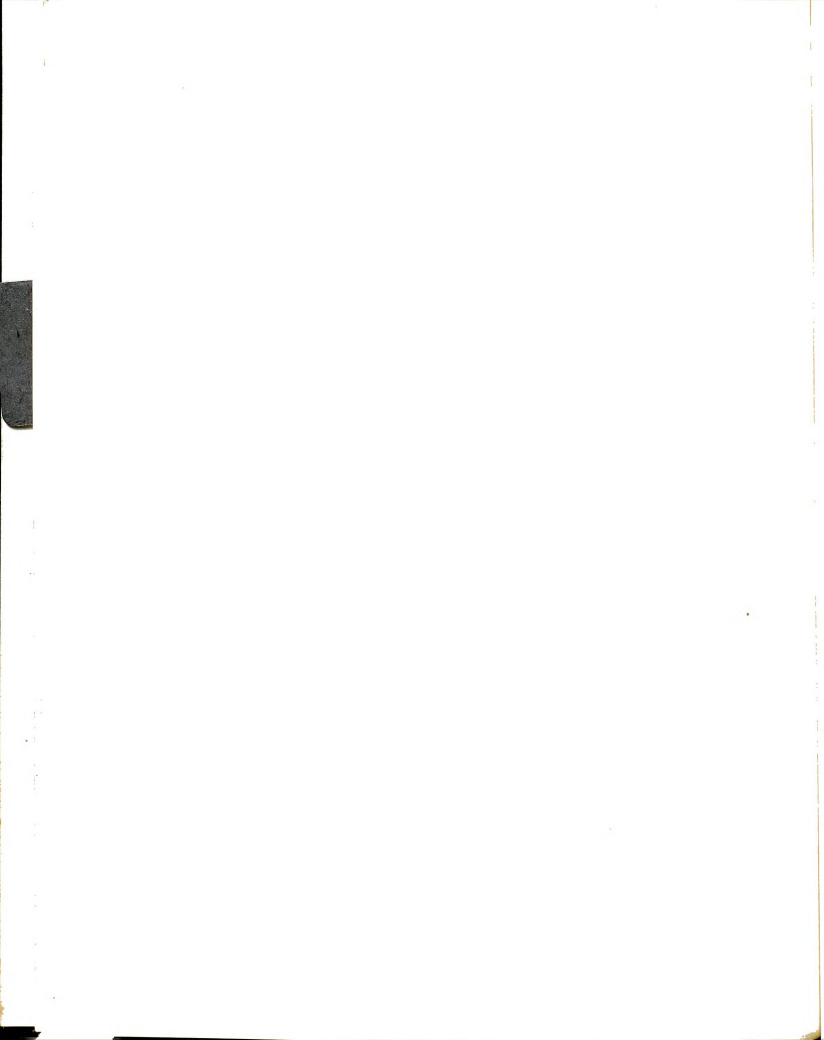
Whether it be to train a farmer to operate a tractor, a teacher to instruct the growing mind, or an extension agent to demonstrate a new idea to a mother, it is the great mass of mankind that must be educated in the every-day things and ways of life.

Since most nations are agrarian and cannot move ahead without agricultural development, one of the biggest hurdles of governments is transforming their agriculture from a subsistence to a market-oriented economy. This can only be done economically when man becomes a director rather than a producer of power. To become a director he must be skillfully trained--mentally, physically, and emotionally. Many nations have tried to introduce modern agricultural machines and practices without first training the ultimate user. Even today, very few programs are operating to try to accomplish the gigantic task of technically training the masses. Few such programs have been scientifically planned or adequately developed to meet the crucial demands of society and its expanding needs. Training programs to work with the disadvantaged

and illiterate youth or adults are especially lacking and limited in scope.

At first thought it seems a simple matter to teach someone how to drive a tractor--perhaps how to drive, but not how to operate it with skill and judgment to produce an economic return. This is part of the problem. It appears to be so easy that few people have given it serious attention or developed the necessary techniques and programs to do it effectively and efficiently. It is easier to teach students who can read and learn than it is to instruct a trainee handicapped by lack of formal education or failure. So the tendency is to focus upon the favored and neglect the lower achievers. The cost is more to educate the latter, yet they are the ones who need the most help and who want and need work skills. The Basic Tractor Operators' Course described in this thesis was designed to serve the needs of such struggling masses, one at a time.

A further potential of the BTOC, however, is not only that it enables a person to operate a machine and thereby become qualified to seek and hold down a better job. An equally significant effect is the realization that training can provide a whole new series of opportunities. The properly trained machine operator has a different outlook on life. Using his newly acquired skills and knowledge, he can move on to other more challenging and rewarding jobs. This generates enthusiasm and encourages



him to try other more difficult tasks. He is no longer completely dependent as an unskilled worker but can now seek other jobs as he gets experience or takes additional training. Once he finds that he can do things on his own initiative, he becomes a constructive force and leader in his society. He can even help to provide new jobs and opportunities for others as he moves on up the skill ladder. Thus each newly trained person, especially within a developing society, can have a multiplier effect and improve standards of living for others as well as for himself.

ACKNOWLEDGMENTS

Sincere appreciation is expressed to Dr. Guy E. Timmons, Professor of Secondary Education and Curriculum, Michigan State University, for his counsel and valued suggestions in planning the course of study in education and for his untiring help in writing up the research and preparing the thesis. Without his enthusiasm and constant support as chairman of the graduate committee, the task would have been more arduous and the results less appropriate.

Grateful acknowledgment is given to Dr. Chester J. Mackson, Professor of Agricultural Engineering, Michigan State University, for the opportunity to conduct the research study on mechanization training. Without his interest, encouragement and support, the project to develop the Basic Tractor Operators' Course would not have been undertaken.

Gratitude is also extended to Dr. Walter H. Scott, Coordinator of the Graduate Students' Affairs Office, and to Dr. Raymond A. Garner, Professor of Secondary Education and Curriculum, both at Michigan State University, for serving on the graduate committee, criticizing the thesis, and offering suggestions to improve the study.

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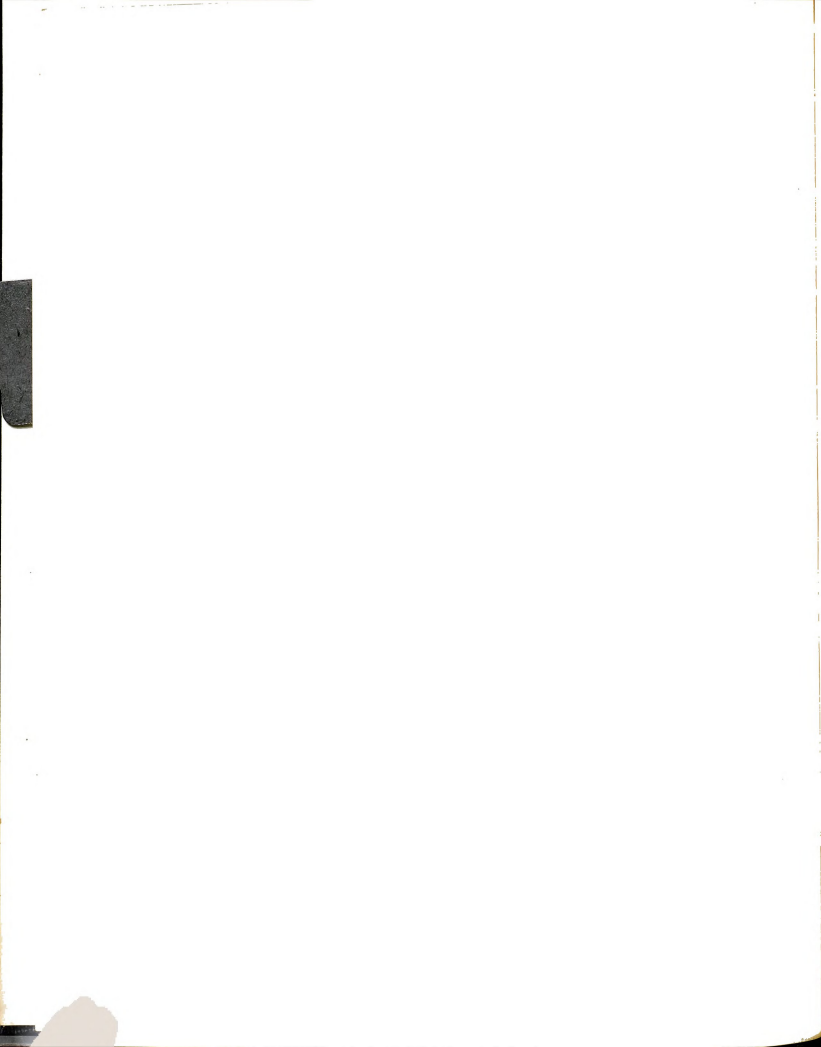
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Thanks is expressed to Mr. George T. French, Senior Vice-President, and to Mr. Thomas H. Bohmker, Product Training Manager, Deere and Company, for understanding the special needs of skill training for disadvantaged persons and for providing the financial support which made this research study possible.

Special thanks is given to Mr. Clinton G. Bolton, former graduate assistant in agricultural engineering, Michigan State University, for his able help in developing and preparing the original text for the Basic Tractor Operators' Course and for his efforts in conducting the preliminary field test with migrant workers. His cheerful and diligent assistance on the Deere and Company project was a key factor in its successful completion.

Thanks is also expressed to Mr. David Burns, former vocational-agriculture teacher at Almont, Michigan, for his work on Section H lessons covering the use of tillage tools in the Basic Tractor Operators' Course. The help of Mr. James Farmer, Director of Continuing Education; Dr. Edward Hotchkiss, Professor of Technical Education, Grand Rapids (Michigan) Community College; Mr. Richard Carlise, Vocational Consultant with the Department of Vocational Education, State of Michigan; and Mr. Howard Doss, Mechanization Specialist, Rural Manpower Center, Michigan State University, is gratefully acknowledged in arranging for and helping to conduct the initial field



test of the Basic Tractor Operators' Course with migrant trainees.

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Finally, I want to dedicate this thesis to my dear wife, Morna C. Kline, for her help, patience, and understanding during the days of travail which made this achievement possible and worthwhile.

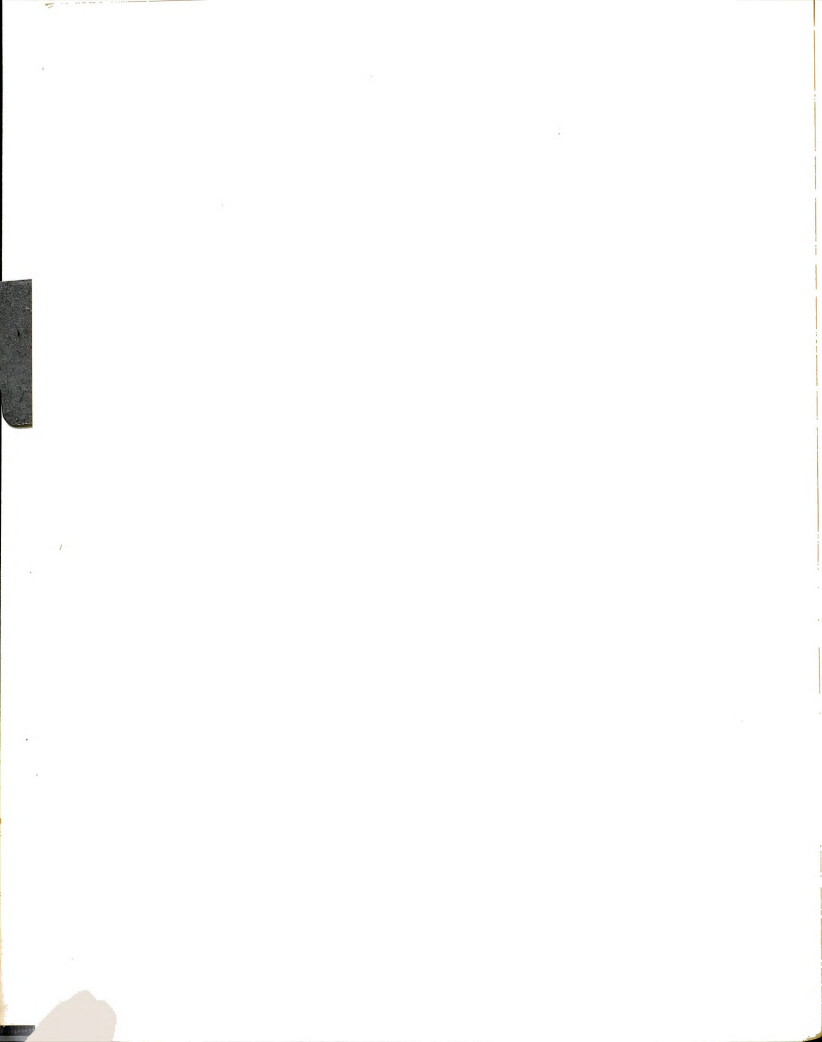


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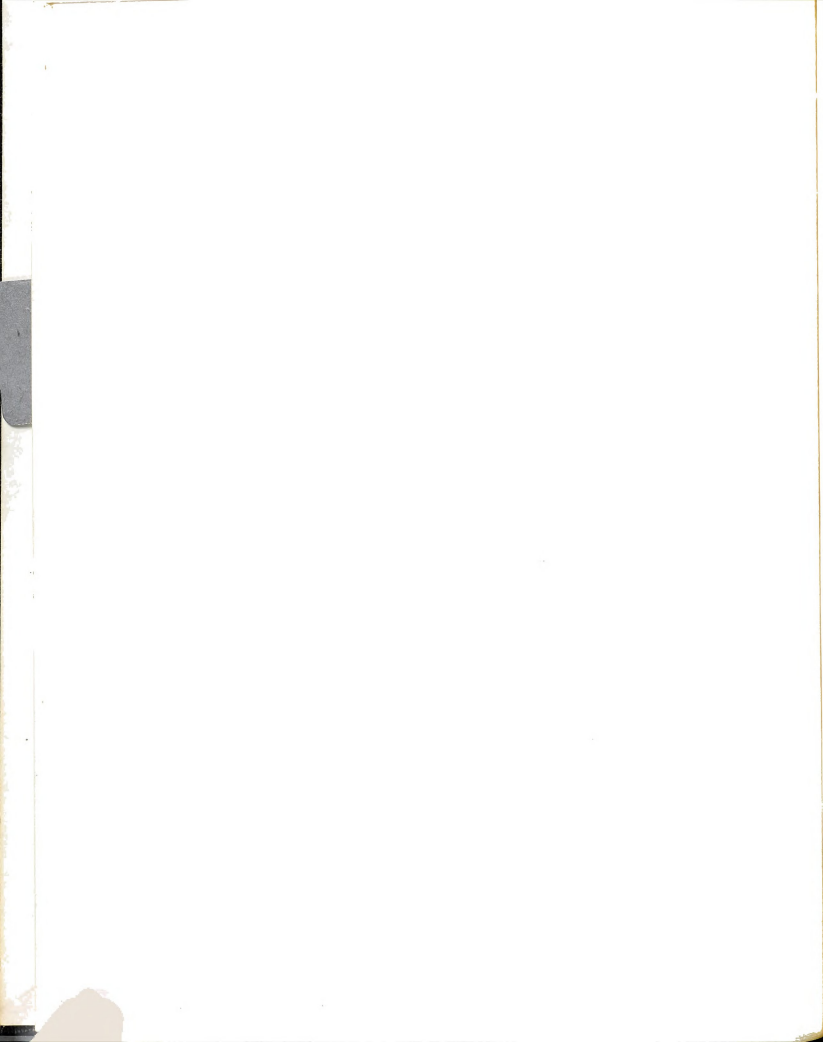
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CHAPTER I

THE PROBLEM

The Needs

Background

In Asia, Africa, Latin America and the Middle East, large numbers of tractors and associated machines have been imported by host governments along with those provided by various foreign technical assistance programs. These machines have been used primarily under government supervision on resettlement schemes, cooperative farms, state farms and large-scale food production projects. A few machines are being purchased by private owners in most countries. Some large commercial plantations producing for export have mechanized their operations in whole or in part.

Surveys and studies in Asia, Latin America and Africa have reported that efficient mechanization of agriculture is still largely a pipe dream. The life of the imported machinery is extremely short and the cost of operation is disproportionately high. Some of this may be due to machine design and material, but most of the difficulty results from lack of knowledge in these countries concerning the machinery itself and its proper use

and maintenance. Tractor pools quickly become junk piles. Once a machine is disabled, it is in danger of being "cannibalized;" that is, parts are taken from a damaged machine in order to repair others. Cannibalized machines rapidly add to the number of unserviceable units.

Governments and industry recognize that training is essential to the proper use and care of agricultural machinery, yet few concrete training programs are in operation. Some existing on paper are seldom workable and train few qualified people. In addition, program graduates seldom return to agriculture but go into other forms of business or government employment instead.

Farm machinery manufacturers are aware of the need for training, the limited resources and success of most programs. In some instances they have cooperated with governments in sponsoring special schools or even in establishing regional training centers. This has been done, for instance, by Massey Ferguson in cooperation with FAO (Food and Agriculture Organization; Rome, Italy) and the Columbian government in Buga, Columbia. Other manufacturers send a training team out occasionally to train their dealer personnel and maintenance people in sales and service. However, little has been accomplished.

In 1969 a cooperative research study was set up between Michigan State University and Deere and Company to develop a program to train machinery operators; namely,

A Basic Tractor Operators' Course, Grade I (Kline, Bolton, and Mackson, 1970). This course could serve also as a model for machines other than tractors in training programs for agricultural machinery operators and technicians. Using techniques developed by systems engineering, the ideas of educational psychologists and methods used by learning systems institutes, this Basic Tractor Operators' Course was formulated, written, evaluated, pretested, refined and field-tested with Spanish-speaking low-education level trainees.

The program was designed to train workers of various educational levels to operate a complicated machine such as a diesel-powered wheel tractor. With this course it is believed that qualified operators--whether migrants or farmers--can be trained effectively and relatively quickly. It is a common belief that good operator training is indispensable and will result in longer engine life, fewer breakdowns, reduced repairs, increased field efficiency, greater tractor and operator productivity and increased quality of work. A worker may gain knowledge and skills and develop a positive attitude toward work and responsibility. However, he must understand why he should do certain things in a specific way and he must be taught.

This training program should have widespread application even in highly developed countries such as the United States, where many untrained potential workers with unsalable skills need new skills or retraining.

Examples of these are unskilled rural workers, disadvantaged people in both metropolitan and rural areas, migrant or transitory workers in agriculture and seasonal industries and school drop-outs inadequately trained for employment. Such mechanization training need not be restricted to tractors or agricultural machinery alone. All of these people have one thing in common: inherent but undeveloped talents and abilities, with little or no opportunity to develop and employ them.

Despite long association with the gasoline-engine tractor, few American farmers know much about the proper care and operation of the large diesel-engine tractor which today produces the power for much of American agriculture. These farmers depend, for the most part, on a strong, well-equipped and trained dealer service organization to keep their machines properly maintained and to bail them out when they get into trouble.

Overseas, the problem of introducing and utilizing modern agricultural machinery is much more acute. Dealers are scarce and generally too distant and often indifferent to the needs of the farmer-user to adequately support him. More importantly, the machine is no better than its operator. This situation leaves practically everything to be desired. All new operators, including hired employees, their supervisors and owner-operators, must be thoroughly trained if the farmer tractor and its associated equipment

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Analysis of the Problem

This study emphasizes the needs and conditions of Africa and, to a less extent, those of Southeast Asia because of the author's extensive recent personal experiences there. The same urgent conditions and general needs for practical training and manpower development apply to all of Asia, Latin America and the Middle East.

The initial objective of this study was to develop a program of training especially suited to the needs of developing countries, but it soon became apparent that the developed countries, as well, have similar problems in training hard core unemployables and the disadvantaged unemployed. All nations, regardless of state of development and level of education, face the need to upgrade the skills and capabilities of the majority of their workers. With more knowledge and power and the great need for rational and humanistic thought and concern, such training becomes increasingly vital with each scientific advance if mankind is to survive problems of its own making.

The Importance of Skilled Workers.--In emphasizing the importance of the skilled technician's role, Wilson, (1968, p. 9), Chief of The Agricultural Education Branch of FAO, states:

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It would be difficult to overestimate the importance of the intermediate-level agricultural technician to agricultural progress in the developing countries. . . . through whose work the results of research and technological progress are conveyed to the farmer and incorporated in agricultural enterprises of every kind. If intermediate level staff are inadequate in numbers or of low competence, then much of the expenditure on the professional staff of the agricultural services is wasted. Depending upon the stage of development and the principal types of agriculture practiced there is probably a need in developing countries for 5 to 10 times as many agricultural technicians as agricultural scientists. . . . the technician's training is fundamentally one of practical application. Not only must he be able to perform efficiently a number of skilled techniques associated with the various aspects of modern agricultural production, but he must understand the basic principles which underlie them. . . . (underlining by author)

The practical know-how of the agricultural technician is something much more than the mere acquisition of a modicum of skill in the manual processes of traditional farming and related agricultural business and industry.

The Low Prestige of Agriculture.--In many developing countries agriculture is a low-status occupation. General education is the basic foundation upon which all vocational, technical and professional education and training is built. The major problem which most developing countries now face is that of modifying and adapting their general educational systems to meet the aspirations, needs and local conditions for national progress and development. Many attempts have been made in the past to introduce an "agricultural bias" into systems of rural education. On the whole, these have not been successful. Wilson (1968, pp. 4-5) points out that:

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The most important has little to do with the educational system; it is that agriculture, as it exists at present in many countries, enjoys so little prestige and offers such poor incentives and limited possibilities of improved farming that it is not worth entering as a career if any alternatives are available. Thus, until there are government policies aimed at the development of a modern, and progressive agriculture, offering reasonable security and rewards to the farmer, there is little point in trying to use the school system to prepare young people for farming.

As a result, there is an equally important need for the regular revision and adaptation of technical education and training to meet the requirements of change and development of the agricultural industry. This change must take place all the way down from the ministers of agriculture and education to the "lowly" farmer and laborer.

There is a great need for intermediate technical training in agriculture. Wilson (1968, p. 7) made a strong plea for special-skill-training with adequate recognition for those who are qualified:

. . . Agricultural scientists, technicians of many kinds and the skilled producer and manager complement each other's work in raising the efficiency of agricultural production. . . . The types of education and training required to produce efficient persons in these three major categories are different in purpose and character and should not be confused. Far too often intermediate level agricultural training is the 'pale shadow of a University degree course' taught by young graduates from their own university course notes. Seldom is the teaching staff . . . adequately supported by the services of skilled technicians to supervise practical training. Intermediate technical training in agriculture is meant to develop real skills in farm management, and the modern techniques of crop and animal production, the use of machinery and irrigation, etc. Let us aim to produce the skilled technician who stands in his own right as one of the indispensable

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elements of the agricultural profession and is not (author's italics) someone who is inferior to the graduate in agricultural science. Likewise, vocational training for the farmer, for rural women, for village craftsmen and others needs to be accorded its distinctive character and dignity.

Manpower Crisis in Africa.--In 1968, the Economic

+ Commission for Africa commented: "African countries currently face a manpower crisis. Middle and high-level technical, scientific, professional and managerial skills are in acute short supply, whilst surpluses of unskilled workers abound" ECA (1968, p. 10). Maddison (1964, pp. 4-5) further asserts, "Some African countries are so short of skills that a good deal of their capital aid receipts are not properly used and their capacity to use larger investment funds is limited." To alleviate the manpower shortages, developing nations are placing increasing reliance on the importation of foreign skills through bilateral and labor market arrangements. In 1963, for instance, Maddison reported (pp. 21-22 and 92) African countries received over 66,600 technical assistance personnel, mainly primary and secondary school teachers. Multilateral and bilateral technical assistance sources provide several countries with top-level expert personnel for the public service, while private foreign investments bring top-level management and technical personnel. Notwithstanding the rapid advances in "Africanization" and "localization" over the past decade, African countries continue to rely heavily

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on external sources for the skilled manpower which their educational systems have been unable to produce.

The Economic Commission for Africa (1968, p. 10) states, "Manpower requirements for the 1970s would have to be of a higher magnitude in terms of numbers and of more complex 'skill mix' in terms of quality, if African countries really mean business with the task of industrialization and agricultural modernization. A better educational profile in the labour force is a necessity for technological progress and structural transformation in African economies."

There is insufficient regional data to indicate Africa's future quantitative requirements for trained manpower. However, data from several countries with established manpower programs generally indicate that acute, trained manpower shortages over the next decade at the middle-level of skilled operators and technicians will constitute a very severe constraint on development. Table 1.1 shows the relative degree of future manpower shortages in a number of African countries (ECA, 1968).

The future shortage of teachers, engineers, scientists and technicians will be critical. In the industrial sector a United Nations survey in 1965 indicates that "Africa would require by 1975 an estimated total of 33,000 engineers and scientists and 83,000 technicians. Of these some 31,000 engineers and scientists

Table 1.1

Future Manpower Supply and Demand Situation in Selected African Countries. (Adapted from ECA data, 1968)*

Country	Plan period	Additional demand and anticipated supply			Net difference			Shortage Surplus	
		Manpower category			Manpower category			-	+
		I	II	III	I	II	III		
Algeria	1966-73	23,000-5,000	70,000-20,000	---	- 18,000 -	50,000	---	-	68,000
Cameroon	1966-71	2,652-1,023	7,004- 5,111	16,756- 16,211	- 1,629 -	1,893 -	---	545 -	4,067
Dahomey	1966-70	914-1,500	---	2,413- 9,000	+ 600	---	+ 8,100	+	8,700
Ethiopia	1968-72	7,131-3,640	6,515- 4,232 ^{a/}	79,499- NA	- 3,491 -	2,283	NA	NA	(6,774)
Ghana	1963-70	12,000-9,050	---	151,500-104,100	- 2,950	---	- 47,400	-	50,350
Ivory Coast	1963-70	6,904-1,156	14,804- 3,644	44,991- 15,249	- 5,748 -	11,160 -	29,742 -	-	46,650
Kenya	1964-70	7,300-6,600	39,900-36,500	26,900- 3,500	- 700 -	3,400 -	23,400 -	-	27,500
Libya	1964-69	5,054-1,841	---	14,357- 7,171	- 3,213	---	7,186 -	-	10,399
Nigeria ^{b/}	1963-68	18,000-8,894	---	44,400- 15,146	- 9,106	---	- 29,254 -	-	38,360
Sudan	1961-71	7,300-6,549	---	39,300- 12,738 ^{c/}	- 751	---	- 26,562 -	-	27,313
Tanzania	1964-69	2,905-1,962	6,555- 5,401	17,262- NA	- 943 -	1,154	NA	(2,097)	
Tunisia	1965-68	4,500-4,000	16,500-12,000	45,500- 76,500	- 500 -	4,500 +	31,000 +	+	26,500
UAR	1965-85	634,734- 388,050	1,409,678- 214,650	690,905-262,550	-246,684 -1,195,028	-428,355 -1,870,067			
Zambia	1965-70	2,000- 650	3,750- 4,800	9,900- 6,390	- 1,350 -	2,810 -	5,100 -	-	9,260

Sources: Compiled by ECA secretariat from published national development plans and manpower survey reports.
E/CN.14/WP.6/18Manpower category:^{a/} Excluding administrative and clerical.^{b/} Upper target - excluding teaching and research staff.^{c/} Adde.: 88,000 administrative, clerical all levels.

NA: Not available.

- I - Persons with university education, professional training or equivalent experience.
 II - Persons with 1 - 3 years' post-secondary, vocational or technical training.
 III - Persons with secondary school education, apprenticeship or craft training.

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and 73,000 technicians would have to be trained by 1975" (UN report pp. 26-29). Very significantly, at the time these estimates were made, the scope of African industrialization was just beginning to be visualized. This UN report (p. 27) goes on to say, "Allowing for some underestimates in the survey, it is probable that the training requirements by 1980 will be about half as much again as that indicated by the survey."

Table 1.2 shows the estimated future manpower requirements for implementing proposed industrial programs in East and West Africa (ECA, 1968). The training bottleneck and greatest need is for skilled and semi-skilled operators of machinery and related processes. This survey does not include projects in vast undeveloped geographic areas and for countless unknown needs yet to be defined. The need for skilled and semi-skilled operators exceeds by over three times all other demands. And these are the people who actually do the work! Moreover, they are the very group which no country could afford to import, even if it were physically possible. They must be local people and they must be trained locally.

In qualitative terms, future development programs will require a labor input of a far better "skill mix" than thus far necessary. In industry, agriculture, transport, commerce or education, skilled operators and managers need to know more about the application of science and

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TABLE 1.2.--Estimated Manpower Requirements for Industrialization Programs in the East and West African Sub-region, 1965-1975.*

Level of Manpower	Sub-region	
	East Africa	West Africa
Senior Management Personnel	34.6	48.7
Engineers and Scientists	7.1	11.7
Technicians	19.0	34.5
Clerical	84.0	120.8
Skilled and Semi-skilled Operators	453.5	666.1

*Source: Data calculated by ECA secretariat (estimates subject to further revision as more refined information becomes available on industrial program proposals). E/CN.14/wp.6/18 (p. 13).

technology to their operations. Each year, a host of new types of skills will be required to cope with resource identification and exploitation. To produce these skills locally, new courses must be included in educational programs. Furthermore, if the present sociocultural and attitudinal restraints on the acceptance of change and innovation are to be eliminated and development attitudes positively enhanced, a completely new orientation toward the objectives and value of vocational educational programs will be needed.

Justification and Need for Vocational-Technical Training in Mechanized Agriculture

Many developing areas of the world have adequate natural resources for food and fiber production. The inhabitants of these areas, however, face severe

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constraints imposed by very limited knowledge and the necessary muscle power available to exploit these resources. Even if adapted and well-designed and manufactured agricultural machinery is made available, government agencies and farmers are often unable to apply it economically to agricultural production tasks. Inexperienced and untrained drivers, tractors and associated equipment not only do poor, but negative, work. Equipment often wears out or breaks down prematurely requiring high allotments of sorely needed foreign exchange for maintenance and expensive repairs.

Effect of Technology on Educational Needs.--Improved machinery must be complemented by improved skills. Farmers and their employees require special training to learn how to operate modern farm machinery effectively and safely, to adjust it properly and to keep it in serviceable condition. In a culture with few, if any, mechanical devices, the people must learn the basic mechanics of machine systems, the requirements for lubrication and cleanliness, the need for regular service and the attitudes and judgments necessary for intelligent operation. Without adequate training, machine operators cannot produce good work or carry out practices which prolong machine life and protect equipment from abuse and damage. They will be unable to use improved power and implement systems along with other major improved inputs of production, management and

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distribution to exploit the potential natural and human resources of the nation for the benefit of society. Thus, the farmer who uses more power, improved power-and-implement systems, must be a better-than-average farmer to make farming pay. The higher cost of this new capability must be compatible with and complement the increased economic return resulting from the application, management and exploitation of these resources.

The Industrial-Agricultural Development Dilemma.--

With reference to the industrial-agricultural development dilemma causing the slow progress made within developing nations and the poor showing being made by the industrial sectors, ECA (1968, pp. 6-8) made these comments about African nations:

. . . When all is said and done, however, the pace of economic progress is critically dependent on agriculture and industry (including mining); and due weight must be given to this fact in any consideration of a strategy for economic development in Developing Africa.

. . . In the last analysis, an adequate supply of well-trained persons is the basic requirement for development. Because of previous neglect of education and training, developing African countries in their first years of independence--were desperately short of skills; and this shortage was undoubtedly a strong contributing factor to the generally slow ratio of growth. A graphic if somewhat impressionistic measure of the shortage of skills may be obtained by considering enrollment in primary schools. On the basis of the most recent information for 52 African countries and territories, the percentage of the 5 to 14 age group in total population in primary schools was less than 50 in 31 countries; less than 25 in 17 countries; less than 15 in 9 countries; and less than 10 in 6 countries.

In the African region the bulk of the labour force is made up of persons without formal education. . . . Resources of scientists and engineers constitute less than one-tenth of one per cent of the labour force in most African countries. . . . Excepting the United Arab Republic (Egypt) and the Republic of South Africa, a relatively high proportion, ranging from under 30 per cent to over 80 per cent of the limited high-level manpower resources is of foreign origin. Furthermore, the labour force has too thin a veneer of science and technology based disciplines to be able to cope adequately with the technological requirements of modern development, without which the desired transition from traditional to modern economic structures will be difficult to achieve.

The Magnitude of the Training Task.--With reference to the magnitude of training needed from another viewpoint, the prospective population increase in the 0-14 age group will accentuate strains in the deployment of material resources. This age group, estimated to account for some 45% of the total African population, will increase in absolute numbers from 155 million by 1970 to around 205 million by 1980 (ECA, 1968). These children and young persons must be fed, clothed and schooled better than their predecessors a generation ago. Increased school enrollment, at all levels, will cause severe strains on public and private financial resources. An increasing proportion of the national income must be devoted to training facilities to satisfy the growing demand for education.

Implications for Educational Development.--As a result of their study of the manpower requirements of developing countries and the implications for human

development, ECA, OAU and UNESCO (ECA, 1968, pp. 14-15)

foresee the following needs:

Increased school enrollments at all levels requiring more teachers, school buildings and teaching aids, furniture and laboratory equipment, higher wages and increased maintenance bills.

Substantial expansion in secondary teacher training and university enrollment to cope with the shortage of middle and high-level manpower, including skilled operators. To improve the "skill mix" of the labor force, expanded programs of science and technical education at both levels will be required to attain the 60 per cent target for students enrolled in science and technology by 1980, envisaged by the Addis Ababa Plan and the Tananarive Conference.

Expanded training programs employing modern teaching aids will be required since teachers are the key to qualitative and quantitative improvements in educational programs, and in the local production of trained manpower.

Orientation in primary education toward vocational training and rural education. New corps of rural teachers to demonstrate agricultural practices, impart skills in particular rural crafts and trades and serve as animators must be developed.

Problems of Cross-Cultural Training

Some common beliefs in developing countries that constrain training:

1. Education "implies" the right to or desirability of a "white collar" job without the need to do manual work, to work with the hands or to get them soiled.

2. Few people have the mechanical background for working with or understanding mechanical devices, machines or gadgets common to the life of more-developed countries.

3. Lack of opportunity has prevented most young people from developing mechanical skills and aptitudes taken for granted in developed societies.

4. Lack of training and inexperience has kept people from learning the need for proper care and the value of preventive maintenance of machines.

5. Judgments and innate abilities regarding the use, selection, application, capability and capacity of machines or devices are undeveloped in the non-industrial societies.

6. Few skilled people are available locally who can teach mechanics, the practical metal arts like welding, blacksmithing or machinery operation.

7. Very few people are available outside major metropolitan areas to service and repair agricultural machinery, tractors, engines and motorized equipment. Very few garages or repair shops exist to serve the automobile; and practically none are found outside the larger cities to support agricultural tractors.

8. Supporting services such as service stations, petroleum distributors, electrical service, agricultural extension services and credit organizations are very limited, and few offer education or in-service training for businessmen, farmers or agricultural workers.

Social and Cultural Problems Affecting Agricultural Mechanization.--Under the present system of "shifting"

agriculture, Coulthard (1969, p. 46) points out that in West Africa:

the father of a family selects a plot for cultivation and performs the clearing operation. He may also plant the seed, but it remains for the women and children to perform the weeding, cultivation and harvesting of the crop. Mechanization will, therefore, require a major change in family patterns. Even religious belief and traditions have an influence on areas which may be cleared and put under the influence of the 'plough.' The family structure of a matriarchial society, the welfare of relatives, and the pattern of communal living, will require education for the next generation or two, to develop a pattern conducive to large-scale mechanized farming. . . .

Animal power and complementary tillage implements have not progressed to any useful stage in West Africa. The Africans now believe they can make the step from the hand hoe directly to the farm tractor. . . . [However] Tractors and farm equipment are not manufactured in the region and export currency must be earned to balance off such importations. Dealers of farm machinery are not suitably situated throughout the country and even in the large centres, long delays in obtaining import permits and the process of importing, coupled with the low parts inventories, discourage the use of machinery.

Value of Practical Training

Africa's requirements for scientists, technical men and operators call for people able to use both head and hands to apply laboratory results and acquired knowledge in solving the practical problems of industry and agriculture. Teachers must be able to give reality to their subjects by drawing on their own practical industrial, business or agricultural experience in applying the theory to real problems.

ECA (1968, p. 3) stresses that theoretical education divorced from practical experience breeds only misfits:

Those who have had the opportunity of this type of education consider themselves only as the elite and are rather reluctant to enter occupations involving manual work. Furthermore, there is a tendency for many technical school graduates to seek employment in the better-paying high-status clerical occupations. Such an attitude of mind and flight from vocational training derive from the fact that the environmental setting in which they live has failed to accord adequate recognition and pay to technical vocations.

Technical and skilled personnel may be trained by actually observing and participating in the working process. They can move from apprentice to engineer or from trainee to skilled operator, on the factory floor, or on the farm field, through apprentice training or by taking specialized cooperative work-study training. The advantage of early exposure to practical work experience is threefold: (1) it facilitates the theoretical comprehension of some abstract subjects; (2) once graduates have finished school, they need less time to adapt themselves to the real world of work; and (3) they will not belittle manual work when entering employment for the first time. As Williams remarked, "No system of technical education is sufficient on its own to create an adequate and efficiently trained work force. A system of technical education must be supplemented by a strong system of industrial [business and farm] training as there are many aspects for which no formal education system can provide

the most suitable and effective circumstances for training" (Wilson, 1968, p. 4).

Rationale for Improved Training Programs and
Manpower Development in Both Developed
and Developing Nations

The Need for Additional Training and Manpower
Development in a Developed Nation

In the United States, for example, the increasing rate of introduction of new technology makes it imperative to give much more attention to the development and evaluation of specialized training programs designed to impart new skills or to upgrade outdated skills. No individual can learn a skill or trade today and expect to be able to practice it without change during his working lifetime. For the new recruit or unskilled laborer this means assessing his natural abilities and aptitudes and selecting or designing a training program to match his current needs, interests and discernible abilities. Training, therefore, becomes a continuous task since all of these factors are undergoing constant change. This applies to large groups of urban and rural forgotten or disadvantaged adults, as well as youth seeking their first full-time jobs. Unfortunately there are many such persons in the United States who cannot compete or qualify for better jobs because they have no saleable trade, industry or service skills.

Training the Disadvantaged Rural Worker.--One example of minority disadvantaged are the Spanish-speaking

American migrant workers of Mexican or Puerto Rican descent. They have traditionally helped to hand weed, thin and harvest much of the commercial fruit and vegetable crops and special field crops such as sugar beets and cucumbers. Because of legislation and inefficient methods, they are already displaced in many cases by intricate and expensive agricultural machinery. With rapid and complete conversion inevitable, these farm workers must acquire new skills essential to the safe and efficient operation of advanced agricultural machines if they are to remain employed in agriculture; and advance into better, more satisfying jobs.

A Classic Example of Training Need.--Few American farmers know all they should about the proper use, care and operation of the large diesel tractor, and few are adequately trained to operate the sophisticated farm machinery demanded by large volume commercial farming. Yet these same farmers are willing to turn over expensive machinery to untrained employees. Their appreciation of the need for training is often lacking. Barnes (1970, p. 18) tells of a farmer who:

. . . was willing to turn his \$25,000 cotton picker over to an [untrained] employee whom he would not trust with his \$4,500 automobile. How little attention is often given to the selection and training of a machine operator! Operation of agricultural machines demands the same skills which the construction, manufacturing and transportation industries require of their operators. These operator skills are an important factor in machine performance.



The skilled machine operator . . . detects trouble before a serious problem develops. The premium wage of a skilled operator can be quickly paid if an efficient harvest brings in extra dollars. A skilled operator who can bring in only an extra ten pounds of lint per acre is bringing in an extra \$2.00 per hour.

Extra pay will not guarantee extra skill. Training is needed. . . . In the years ahead three factors, (1) higher wages, (2) year round employment, and (3) higher quality, more expensive machines, will combine to make formal training to provide skilled machine operators an essential part of production agriculture. (underlining by author)

The Need for Improved Training and Manpower Development in a Developing Nation

The problem of developing a qualified source of manpower for agricultural and industrial development in developing countries is even more acute since the need for skilled machinery operators is directly related to food shortages, inefficient agricultural production and rising food costs. Low educational standards, non-mechanical background, traditional beliefs, undeveloped abilities and social customs impose still further restrictions. These factors make special demands on the type and nature of training programs required to acquaint workers with the more advanced scientific and industrial occupational skills and attitudes.

The Plight of Middle-School Leavers.--In many developing countries today a growing body of middle-school leavers with some general education are unable to qualify for skilled or semi-skilled work. They cannot go on with their formal education because there are insufficient

secondary schools, vocational or technical institutes or other curriculums. The chances for one of these higher education programs are practically nil for the vast majority of primary school graduates or middle-school leavers. These students are in essence overly educated for work but under-educated to perform useful work in society. All nations recognize the seriousness of this situation.

Planning Essential for Manpower Development.--To use available resources to the best possible advantage to achieve the maximum rate of economic and social development, manpower development must be planned. Wilson (1968, p. 16) states:

. . . the assessment of the needs, short-term and longer-term, for trained manpower in all sectors of the agricultural economy, and at all levels, is seen to be a most important continuing process to provide the framework of institutional planning. It is impossible to devise appropriate curricula and to provide essential facilities for agricultural education and training in the absence of detailed specification of many technical and professional duties for which trained people are required.

"Job specification," therefore, is also an important component in planning technical education and training for agricultural and rural development, within the context of national development planning.

Agricultural education and training broadly falls into three categories: higher, intermediate and vocational agricultural training. Each level has different objectives and serves different needs in agricultural development.

Wilson (1968, p. 16) reiterates, "It is most important that this fact be recognized in curriculum planning. Of equal importance is to appreciate that all levels need to be developed as an integrated whole, each level complementing the others and contributing to their effectiveness. The most vital aspect of developing the whole structure is teaching staff: their selection, professional training, technical support and periodic in-service training." There is also an urgent need for a supply of adapted and relevant textbooks, manuals and teaching materials for use, at all levels, in developing countries. These need to be based upon local needs, local research and experience, and the actual economic and social conditions of each country. The universities, with their excellent staff and facilities, have a challenging role to play in meeting these needs for updated and pertinent textbooks and teaching materials.

Purpose of the Research Study

To increase the effectiveness of training programs for teaching low education level trainees in developing countries and disadvantaged people in developed nations by providing a standardized course of instruction based upon needs.

To design a basic program for training machinery operators that can be adapted to the individual resources, requirements and aspirations of a nation.

Hypotheses of the Study

A different type instructional program is required to adequately train disadvantaged or low-education level personnel to operate complex machinery in both developing and developed countries.

A properly structured training program will significantly decrease the time it normally takes to train qualified machinery operators.

A meaningful final evaluation of illiterate or low-education level tractor operator trainees can be made by using specially designed performance tests and visual observation procedures.

From a cultural mix it is possible to select trainees more receptive to training by a series of pretests to identify those with higher than average aptitudes and states of trainability, irrespective of literacy level.

With relevant behavior tests to identify and compare mechanical aptitude and general learning perception, it is possible to predict which trainees of various cultural backgrounds are most likely to become good tractor and machinery operators.

Trainees given a specially designed program of instruction based on structured learning, will learn faster and remember longer than those given the usual lengthy random course or brief and unorganized training.

The bilingual local leader, adequately trained as an instructor, can more effectively train local people of his own language and background.

By providing an instructor with a detailed training program and a definite period of in-service training to learn how to use it, a superior type of uniform instruction will be presented to trainees.

Uneducated trainees can learn to become good machinery operators capable of exercising basic judgments and decisions by completing a practical course of "hands on" real life training.

Tractors and machinery used and cared for by trained tractor operators will last longer, require fewer repairs, have lower operating costs and have a higher hourly productive output than machinery driven by tractor drivers who are untrained or trained by traditional haphazard methods.

Objectives of the Study

To establish minimum levels of knowledge and skills needed by a basic tractor operator (Grade I) to perform satisfactorily in the field.

To develop the format for a basic universal tractor operator's course which will provide the learning environment needed to convert an illiterate or low-educational level trainee into a qualified "Grade I" tractor operator.

To determine the length of training program needed to train people with varying entry behavioral characteristics, to a given level of expertise as a "qualified" tractor operator.

To determine the best learning sequence and methods of presentation to minimize boredom and motivate machinery operator trainees to accept responsibility through the development of proper attitudes.

To develop lesson pretests for evaluating entry behavior characteristics of illiterates and others with low-education achievements.

To develop a total course evaluation procedure for measuring the effectiveness of the training program and the relative ability of the trainees on a continuous basis.

To develop a method of performance testing to measure trainee achievement fairly and accurately and to act as a basis for certifying that the trainee meets prescribed standards as a qualified tractor operator.

To develop an "instructor's manual" to act as a guide and reference for instructors in teaching trainees in a practical non-verbal and verbal "hands on" and "learning by doing" approach emphasizing individualized instruction and learning.

To develop an effective training program to teach potential instructors how to use the prepared "instructor's

manual" and guide to train trainees in their local language in familiar surroundings.

To develop simple teaching aids which could be easily reproduced in local languages and used to remind trainees of the important maintenance services, safety precautions and judgment factors which make a good tractor operator.

To determine if it is possible to use a standardized general-aptitude test developed in a developing country to pretest and predict which applicants are most suitable for training or most likely to make good tractor operators.

To determine if it is possible to preselect and weed out trainees unsuited for training as machinery operators or to identify those who are most likely to fail or to make unsatisfactory tractor and machinery operators.

Definitions Used in the Study

Terms used in the Systems Approach to Mechanization Training Programs with Structured Learning and Evaluation are defined as follows:

Aptitude.--The human capacity to learn and modify behavior as the result of selected stimuli and internal and external influences.

Aptitude Tests.--Carefully designed and administered tests to help students and trainees, parents, teachers and counselors to better understand the trainee's inherent and natural abilities, limitations and weaknesses so that the

trainee can more wisely choose a satisfying occupation or career.

Behaviorial Objectives.--A desired change in human behavior stated in measurable terms of attitudes, skills or knowledge (ASK) and used to satisfy an instructor that a trainee can perform a task defined as a desired outcome of a course of instruction. They are approximations of the system objectives.

Certification.--A statement issued by the training officer vouching that the holder has graduated from a training program upon the attainment of certain standards of achievement and performance.

Conference-discussion.--A method of instruction involving the active participation of the trainee in a learning process using as many human senses as possible, in a practical and stimulating group experience with questions and trainee performance.

Daily Maintenance.--A series of services habitually performed daily by the trained machinery operator to prepare his equipment for field operation with the objective of prolonging the life of the machine, preventing unnecessary breakdown and reducing both repair costs and unproductive downtime.

Disadvantaged Person.--Anyone entering a training program in a position inferior to his classmates or other similar individuals in the population because of a lack

of or a deficiency in some area; or one who has an inferior concept of his ability because of prior experience with prejudice or bias due to race, creed, color, culture or education.

Deficiency of Training.--Any substandard performance in the acquisition or evaluation of Attitudes, Skills or Knowledge (ASK) which is correctable by additional training.

Educational Effectiveness.--The attainment of desired changes in student and trainee behavior within the context of adequate performance in the least time with minimum cost based on feasible allocation of resources without imposing unacceptable constraints on any other elements in the total system.

Educational System.--A rational, controlled set of relationships among various elements interacting in a specific environment at a particular time with motivational factors to produce stated behavioral changes in individual learners. It includes the whole process of students, teachers, curriculum content, instructional materials, instructional strategy, physical environment and the evaluation of objectives.

Entry Behavior.--The attitudes, skills and knowledge held by an individual at the time of entry into a training program which form the base upon which further training and change in behavior must be built.

Evaluation of Learning.--Any form of assessment or analysis of a present condition or experience which permits a continuous reevaluation or refinement of some action which took place in the past, is currently in operation, or may take place in the future.

Environment.--The total setting and background in which the messages, man and resources interact to acquire known facts or develop new ideas and concepts.

Failure in Learning.--A condition which occurs when a teacher has failed to teach so that the learner has been unable to learn or benefit from the educational process.

Feedback Evaluation.--The technique of continually taking stock of current events and using the analysis and resultant data to modify, correct or otherwise improve on-going or future processes.

Flow Chart.--A visual means of programing a sequential series of actions which at the same time may be concurrent, straight line, repeatable, divisible, terminal or continuous. (Sometimes called Critical Path Method, Program Evaluation Review Technique or Logic Tree.)

Formal Learning Experience.--Any set of predetermined structured conditions which produces a desirable change of behavior in an individual.

General Aptitude Test Battery or GATB.--A combination of four verbal and eight nonverbal general knowledge

and performance tests developed by the U.S. Federal Employment Security Service to assist qualified counselors to measure certain characteristics which help to identify natural talents or capacities to learn in humans.

"Hands On" Instruction.--All types of conference-discussion, laboratory or field practical exercises in which the trainee experiences a "live" personal involvement with his hands, head and total being.

Hardware.--Various devices used by instructors to store, transmit, compile, analyze and perform routine functions with training resources to assist the learner and reinforce the learning experience.

Individualized Instruction.--Any teaching technique to tailor the course material, the rate of learning and the instructor's presentation to the needs of the individual learner, including counseling, motivating, listening, etc.

Instructional System.--A method of teaching conceived around the formulation of objectives, the development of test criteria based on the objectives, an analysis of the learning tasks, the design of a specific course, the implementation and testing of the learning output and the continuous evaluation of inputs and outputs to improve the educational process by changing or modifying components in part or total, similar to the techniques used in the systems engineering approach.

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Instructional System Components.--All of the

resources which can be designed, stored, applied, controlled, combined and utilized in a systematic manner with the intent and purpose of changing behavior in a positive way to bring about learning.

Instructor in Charge.--A professionally-trained

teacher possessing special qualifications in technical competence and methods of instruction who has, in addition, been trained in a specific Instructor's Training Program aimed at improving his capability in teaching mechanization to trainees of all education levels.

Instructional Technology.--The development

(including research, design, evaluation and production, pretest, support and supply, utilization) of instructional system components (including messages, instructors, trainees, materials, resources, devices, environment, techniques) and the management of that development (including organization, information, personnel) in a systematic manner with the goal of solving instructional problems and providing an effective learning system.

Job Description.--A set of statements which define

the general nature of a job and its related duties and responsibilities.

Large Group Activities.--Instruction presented to

larger groups of trainees up to 20, or possibly 30 in number, by the head instructor, helped by his assistants,



utilizing primarily the conference-demonstration type of presentation, including slides, charts, models, chalk-board or other inexpensive visual and audio aids that can easily be heard and/or seen by the entire group.

Mechonomics.--A relatively new term describing or denoting the relationship between man, his machines, their management and economical use for the ultimate benefit of mankind and his environment; in this case concerned specifically with the problems of accelerating the development of rational and selective mechanization of agriculture and of vocational-technical education to bring about this change in the most effective manner.

Migrant Worker.--Any class of transient worker, usually but not always, of foreign origin, not permanently employed in any one community, who generally works at or near the minimum wage level as a hand laborer in the fields or processing plants serving agriculture.

Modified Structured Learning and Training Environment or MSLATE.--A series of carefully planned and controlled preconditioned learning situations and experiences specifically designed to train low-education-level trainees to become qualified machinery operators in a minimum time with maximum utilization of resources and carefully structured inputs, including a training program for instructors to insure maximum competence.

Occupational Cluster.--A grouping of occupations or jobs having a common core of basic skills and knowledge which permit a person possessing these to qualify for entry with little or no additional training.

Para-professional.--A person qualified by experience, technical training and developed expertise to work or perform in a skilled trade or craft (which may or may not be licensed, unionized or controlled by apprenticeship, examination and a governing body or bodies) who can act as an instructor or teaching assistant.

Performance Activities.--All types of human mental and physical activities which can be measured and rated by comparison with agreed-upon standards.

Pretest Evaluation.--A preliminary test of mental knowledge or attitude or manual skill given prior to training to help establish entry level behavior and guide the instructor in adapting his techniques and course material to the needs of the trainees, individually and collectively.

Post-test Evaluation.--A follow-up test of mental attitude, manual skills and knowledge given after training is completed to determine what and how much the trainee has learned and how well the instructor has taught.

Practical Exercise.--A learning activity conducted in an atmosphere of MSLATE in which the trainee is actively involved, on his own, under minimum supervision, in the

laboratory or field, with emphasis on learning by doing through participation in "hands on" activities.

Program Evaluation Review Technique or PERT.--A technique--developed by the Defense Department, since adopted by most large corporations, and now popular with educators, administrators and professional people of all types--designed to simplify, control, review, analyze and expedite the discharge of management and administration associated with increasingly complex and structured organizations; with greater assurance of making rational and intelligent decisions based on known facts, calculated risks and considered judgments.

Qualified Tractor Operator.--Any trainee who has successfully completed a course, such as the Basic Tractor Operator's Course described in Chapter III of this dissertation, as evidenced by passing the Final Evaluation and being subsequently certified as qualified by the training officer as a Basic Tractor Operator: Grade I (Minimumly Qualified); an Advanced Tractor Operator: Grade II (Semi-qualified); or Certified Tractor Operator: Grade III (Fully Qualified).

Rational Selection and Control.--The identification and management of elements in one complete system such that the results of the interacting components are relatively predictable in producing clearly defined and attainable goals.

Resources of Education.--All ideas, funds, programs and other items commonly called "software," which facilitate or store messages, information and data for transmission, compilation or analysis in the total process of teaching and learning.

Special Aptitude Test Battery or NATB.--A battery of eight nonverbal capacity and performance measuring tests developed by the U.S. Federal Employment Security Service to detect or estimate the degree of vocational technical skills possessed by low-education-level trainees. This test is not yet available for general use but was scheduled for introduction in selected areas of the U.S. in the fall of 1970.

Structured Learning and Training Environment or SLATE.--A carefully planned, structured and controlled series of learning situations designed as part of an environment conducive to learning based on the research of educational psychologists.

Small Group Activities.--Any training activity or learning experience best handled on an individualized basis with a maximum group size of 4 to 5 trainees for effective participation and individual evaluation and practice, with special emphasis on "hands on" or practical learning-by-doing training.

Standards of Training.--A precisely defined set of criteria based on the behavioral objectives of ASK

(attitude, skills and knowledge) training used as a basis for comparison with the trainee's record of performance to determine the degree of proficiency attained in or through training for the basis of certification.

System Objectives.--General goals of an educational system such as the value judgments of its people, national goals of literacy and technological advancement. They represent the value judgments made about a system's desirable goals.

Task Description.--A set of precise statements which describe in brief each key specific detail element making up a task as a part of a larger task or job analysis. Tasks have a discrete beginning and end which can be separated from other tasks--they can be looked at from what gets done and what the worker does.

Teaching Aids.--Any form of audio, visual, olfactory or other type of sensory materials, including actors, which are used to increase the realism or the effectiveness of the learning and training environment, with special emphasis on visual aids with moving or dismountable parts usable by the trainees in self-instruction.

Teaching Assistant.--A qualified instructor, who may be a para-professional, specially selected to work with the head instructor and assume responsible charge of a specific group of trainees and their activities; may be further qualified to work with low-education-level trainees



as a graduate of some type of Instructor's Training Program such as that outlined in Chapter V.

Techniques of Instruction.--Routine or special procedures for modifying, adapting, applying and evaluating educational resources involving man and any combination of software and hardware devices to bring about learning.

Tractor Hire Service.--A public or privately-operated service business specializing in contract and custom work for farmers or farm production corporations in which specific services such as plowing, harrowing, planting, cultivating, mowing, threshing, irrigating, grinding, etc., are performed for a specified price and terms.

Training Sponsor.--Any public or private group or individual giving support or providing training for applicants, with or without tuition, scholarships or subsistence grants, to permit them to enroll in a specific course and receive training for occupational or vocational technical qualification.

Trainee Attitudes.--The invert and overt thoughts and feelings of an individual that cause him to develop conscious and unconscious responses to specific stimuli and experiences which may be generally described as Positive (+), Neutral (0) or Negative (-), and condition his capacity to learn or change to benefit from a learning experience.

Universal Course.--A specially designed course developed to train machinery operators and based on MSLATE, whose format and application can be adapted to teach any education-level trainee how to properly operate, care for and maintain any model of any make or type of machine; with special emphasis upon the use and care of diesel-powered agricultural wheel tractors and their equipment.

Weekly Maintenance Services.--All preventive maintenance and lubrication services habitually performed at the end of 50 hours, or once a week, by the trained tractor operator to prolong machinery life, reduce costly breakdowns, minimize repairs and increase the productive output of man and machine.

World-wide Operator Symbols.--Symbols used in place of words to promote the international understanding and ready identification of operator controls without need for language translation.

World-wide Traffic and Road Signs.--International symbols and standardized sign shapes used with a minimum of words to instruct all motorists and machinery operators in the safe and proper operation of engine-powered vehicles on roads, highways and streets of cities and rural areas.

Overview of the Study

The remainder of this dissertation will present the effect of technology on education and training. Selected cases of training will be reviewed. In addition,

some supportive research to improve Instructional Systems and the Systems Approach to Instruction System Design and Testing will be discussed.

Taking the concept of a Modified Structured Learning and Training Environment (MSLATE), a unique training program was developed to train unsophisticated low-education-level trainees to use, care for, maintain and make judgments on very sophisticated machines--products of high-level technology and education. The "systems approach" of problem analysis developed by engineers was used to define job specifications, analyze task descriptions and prepare a detailed program of training based on the achievement of a minimum proficiency or standard of training. The qualifications as measured by performance testing then became the minimum acceptable level of training for a Basic Tractor Operator, Grade I. Then, with the special needs of overseas countries and of all disadvantaged trainees in mind, a training course was designed tailored to the constraints of cross-cultural teaching, limitations of time, the low-entry levels of unskilled workers and the limitations of training resources, including qualified instructors.

Using a typical lesson from the Instructor's Manual for a Basic Tractor Operator's Course, the rationale and design of this universal type course for training machinery operators will be explained. Examples will show the use

of behavioral objectives, information for the trainees, special teaching techniques where applicable, and large and small group instruction to individualize learning and stress trainee involvement. The method of evaluating trainee competence and performance will be emphasized based on the original statement of the behavioral objectives through to the final evaluation of the trainee's certification. Illustrations will show how emphasis was placed on the development of proper attitudes along with the acquisition of skills and knowledge.

The proposal for pretesting the tractor operators course will be presented along with the results of a preliminary testing program with Spanish-speaking migrant workers in Michigan. Finally, the implications for improved cross-cultural training and the cost effectiveness of this type of training will be reviewed.

CHAPTER II

THE REVIEW OF LITERATURE

The Effect of Technology on Education and Training Needs

Agricultural Mechanization in Equatorial Africa

Governments have tried to organize training programs to spur lagging agricultural economies but few have been even moderately successful. Many skilled and technical education programs are pursued half-heartedly turning out poorly qualified, unmotivated workers. During a study by the African Mechanization Team in Equatorial Africa, only three programs were found making headway in training local nationals to assume responsibility for the proper care, upkeep and operation of modern agricultural machinery (Kline, Green, Donahue, and Stout, 1969).

Two of these programs, the Kenya Ministry of Agriculture Maisai Wheat Scheme and the Ivory Coast "Motoragri" agricultural development organization, were government operations assisted by an outside technical staff to do specific tasks. Training was only a complementing function to facilitate a larger mission. Most training took place in on-the-job experiences under well-qualified foreign supervisors and instructors who acquainted the trainee with

the real work world. Concrete achievements to reinforce the trainees' success experience resulted from this training.

The Narosurra Farm Mechanization Training Scheme is conducting the only course strictly tailored to meet the needs of Kenya's native farmers and operators of private tractor-hire services. Details on these programs are given in the MSU/AID Research Report No. 6, cited above.

In West Africa, Coulthard (1968, p. 42) reports that:

Trained operators and operators with mechanical "sense" are in short supply for the operation of tractors and machinery on present State and Research Farms. Training schools will need to be established for operators and servicemen prior to any large-scale mechanization program. . . . Education at all levels is one of the basic needs in all of the developing countries. . . . The elementary and secondary schooling requires considerable expansion and there is a great need for qualified teachers at this level. . . . There is a great need for technical scientific supplies and educational aids. . . . At the advanced level of education there is a great need for skilled technicians and university trained scientists. At the present time the greatest need is for technicians to operate the current scientific equipment, and that which is about to be introduced. Research scientists find much of their valuable time is consumed in performing routine tasks which could be carried out by skilled technicians, if they were available. . . . One could frequently note the lack of technical training in farm mechanization, in industry. . . . Many more schools offering science training at the secondary level and vocational or technical institutes at the advance level are required.

In East Africa Denike (1969, p. 42) states that:

anything more than survival is basically foreign to the African and the practice of affluence is strictly of



European or Asiatic importation. Such words or phrases as 'mechanization,' 'economic production,' 'rotation,' 'crop sequence' and the like are unknown or wholly without meaning to East Africans. . . . the practical application to different crops, soils, districts, etc., is a baffling and frustrating experience for them. Without rudimentary educational advantages, the African is unable to apply his native skills to even the most basic or rudimentary techniques of modern advances.

Strangely enough, Denike (1969, p. 44) points out, "there has been an almost universal acceptance of some of the most technologically advanced mechanical devices, such as, the self-propelled, combined reaper-thresher!" He does not say, however, that the successful introduction of such machinery depends on the availability of well-trained local operators and the essential infrastructure of supporting services.

Denike (1969, p. 45) goes on to say, "too little interpretive guidance has been offered or accepted. One of the prime needs at the present time is to provide 'push' required to launch or activate the programmes of production which have been studied and recommended for the areas under consideration . . . short-term projects must be started and corrected or the long-term projects will never become activated." Basic to all such projects and the main theme of this dissertation is the need for manpower development and the activation of adequate training programs for the systematic development of human resources.



The Africa Mechanization Study Team made the following recommendations and suggested general guidelines concerning development training:

Recommendation to Develop Facilities for Training in the Use of Farm Implements and Power Units (Kline, et al., 1969, pp. 1-62).

The adoption of improved farming practices, including new forms of farm power generally depends upon the availability of improved tools which require well-trained and careful operators. Such training also plays an important role in reducing repair and maintenance costs. It is recommended, therefore, that extension services be regarded as the most appropriate training medium for small farmers, and that extension agents be provided with adequate training in agricultural mechanization. The training facilities can then be made available to farmers with adequate backgrounds to benefit from the experience.

Facilities for training both farmers and farm operators are generally inadequate. Moreover, very few training programs are designed with due recognition to the farmer's traditional background or level of literacy, their lack of disciplined organization, or their lack of training in mechanical arts. Often, extension workers are inadequately familiar with the farmer's way of life and have, themselves, insufficient knowledge about or proper training on improved mechanization tools and techniques.

Again it should be emphasized that training facilities in these areas can be efficiently grafted onto the operational organization of already established institutions. The burden of expensive administration can be avoided wherever an appropriate institution already is functioning.

Guidelines: Establishment of General Training Facilities (Kline, et al., 1969, pp. 1-76 to 78).

The availability of capable instructors sympathetic to farmers' problems is vital to developing a mechanized agricultural technology. In the contemporary situation, few farmers would be able to enter agricultural training institutions; most teaching would be undertaken in the field by extension workers who must be adequately schooled in the relevant practical skills of agriculture.

In order to strengthen training facilities in agriculture, the following are guidelines for policy-makers:

1. Present extension workers should have ample opportunities, through regular refresher courses, for practical training on the selection, application, use and maintenance of improved implements and farm power units. Foreign-based local farm machinery agencies can provide information and training facilities;

2. Agricultural extension services should be expanded by choosing personnel well qualified in agricultural mechanization, and services should be concentrated in areas of greatest agricultural potential;

3. Time allotted to practical training and selection of improved implements and machinery should be expanded;

4. Curricular content of all training institutions should be carefully reviewed regularly to eliminate unnecessary or irrelevant theoretical courses, and to keep skills related to practical problems of farmers;

5. Training for farm-equipment advisors and technicians should emphasize the interrelationship between improved equipment and improved cultivation practices;

6. Training schools for agricultural mechanization should be considered as appropriate adjuncts to agricultural colleges and/or research institutions;

7. More manuals and instructional literature for the training of extension agents written in appropriate languages are needed, and special techniques for instructing illiterate farmers*;

8. A comprehensive training program in the use, operation and maintenance of farm machinery can be a required part of any agreement for purchasing farm machinery under loan or on credit. The cost of this training should be included in the terms of the loan, and training should be completed satisfactorily before the equipment is delivered. Farm machinery dealers should be encouraged, or even required to offer training courses;

* It is possible to use agricultural literature, machinery manuals and other literature in local schools where the children of many illiterate or semi-literate farmers are students. Students may then help their parents to understand what is written in their own language. . . .



9. Loan applicants should be tested for mechanical aptitudes and responsible attitudes. Any training given to loan applicants should (a) be specifically related to the equipment being purchased and demonstrations [should] take place in the location of intended use, (b) include after-training through visitation of the user on his farm by extension agents of the equipment dealers, (c) insure that extension agents are familiar with the content of any courses taken by farmers in their own location;

10. Where foreign specialists or advisors are employed, the host country should supply at least two nationals to be trained similarly to take over major responsibility for the program at the earliest possible date.

Mechanization Training in Europe and Africa

Another study by Mackson (1969) for Deere and Company in Europe, the Middle East and North and East Africa, found that people and governments talk about training machinery operators, but very few viable programs were in operation and none had detailed lesson or course plans. Furthermore, few courses stressed the basic fundamentals of tractor care and maintenance. In general, the tractor-hire services, farmers institutes and the so-called "mechanization schools" taught tractor driving only, which is a minor part in developing qualified tractor operators. Note that a distinction is made here between a "driver" and an "operator." Farm machinery dealers overseas typically trained a new tractor operator by asking a salesman to demonstrate the equipment and perhaps spend a few hours with him.

Mackson's study indicated a great need for trained technicians in all aspects of agricultural mechanization



in developing countries. This need included not only inadequately trained tractor owners and operators but dealer personnel, government officials and others working in mechanization. Mackson (1969, pp. 1-2) concluded:

there is a serious lack of the most basic training aids, textbooks, and other teaching materials. . . . Training is one of the most important factors affecting market penetration in developing countries. An indepth investigation of the ways in which industry can help the already large number of teachers of mechanization to do a better job seems desirable. Common teaching materials can be used despite wide variations in physical conditions and teaching proficiency encountered at the various levels of training.

Training of illiterates can best be accomplished by 'on the job training,' on an individual basis. Training of these people except in special cases should be the responsibility of the respective governments. . . . While agreeing that a completely different approach for each country or regions is almost certainly unnecessary, it is important that programs fit the areas and needs of the particular group--perhaps not vice versa. The approach recommended is to take selected areas and develop suitable teaching techniques and materials for those situations and then proceed to universality.

Training Techniques Used by the South African Sugar Industry

In developing countries, large commercial farming operations have successfully trained the manpower they need for specialized operations. The large sugar plantations show what can be done to tailor skill training to the trainees' background and needs and the job to be done. They have gained considerable experience and expertise working with local people who with proper training, have become qualified tractor and machinery operators.



In answer to specific questions, Bartlett, formerly
 Director of Training for the Experiment Station of the
 Sugar Association of South Africa, made these comments: *

What type(s) of Training are needed? If it is
illiterate peasant type labour which has had no
 previous contact with our mechanised society, then
the training should cater to teach the operator the
basic elements of operating the machine only. Very
 elementary maintenance procedure should be taught,
 e.g. to watch tyre pressures, water and oil levels,
 grease-points, etc. I feel that to take the training
 beyond this point at the early stage of the indi-
 vidual's development will meet with much frustration
 due to the individuals' limited knowledge, ability,
 experience and appreciation of things mechanical.
 Make no mistake, you can take a primitive African
 and train him to become an expert machine operator
 in the sense of operation only. But do not expect
 him to understand the niceties of listening for
 mechanical breakdowns, such as hearing 'knocks,'
 loose chains, load limits, etc.

. . . Practical training is essential in order to
 master gear changing, operation of equipment,
 reversing, steering, etc. Once he has mastered
 the basic operation of the equipment, he will probably
 surprise you with his ingenuity when operating under
 difficult conditions, and in his attempts to get the
 job done, albeit that it might be at the expense of
 the machine.

Once the primitive operator has gained the practical
 operating experience, and the experience of having a
 frustrated boss yelling and cursing at him for wrecking
 the machine, he will have reached the stage where he
appreciates that the machine is not indestructable and
that it displeases his boss when he wrecks it. At this
 stage, he becomes more susceptible to further training.
 This limited period, naturally will be lengthened or
 shortened depending on the degree of sympathetic
 supervision and training given. Training must take
the form of constant repetitive instruction with the
trainee repeating, parrot fashion, the instructions
given until gradually the point sinks home.

* Letters to C. J. Mackson, dated 25 November 1969,
 and to C. K. Kline, dated 29 June 1970, from George Bartlett,
 Director of Operations for Illova Sugar Estates, Natal,
 South Africa (Underlining by author) pp. 1-3.

Once you have an experienced operator who has seen a wrecked engine and gearbox, etc., the training becomes more effective and can be carried further to include minor repairs, implement adjustments and the 50 or 100 hour servicing. Once again, he is keen to learn and is trainable but it must always be remembered that he is illiterate and has, believe it or not, no earlier experiences such as closing a car door, tightening nuts, using a screwdriver, etc., and as such has his limitations. You might find it hard to believe that I know of a young tractor driver who within his first week of employment on a farm, and when closing a pick-up door, slammed it while holding tightly the door's window frame. The result was broken fingers. When asked why he did such a stupid thing he replied that he didn't know it would hurt him. He had never closed a car door before. Today he is a successful tractor driver.

On the other hand, the laborer may be literate and from a more civilised background. Under these circumstances, the practical training should run parallel with formal instruction of such subjects as why it is important to have clean air, fuel and oil, why the correct clutch and brake adjustments are necessary, etc. This should be done by repetitive type instruction and practical demonstration.

The ultimate, of course, is to have some form of training amongst the youngsters at school in preparation for the eventual driver and operator training.

Who should give training? A qualified person who is fluent in the language of the trainees and preferably of their same race. The latter is important because some people believe that since it is the white man's machine, only he can really understand it. In Natal, for instance, our Bantu (African) instructors are able to motivate Bantu drivers far better than can White instructors, primarily because of the above fact and because they understand the thinking of their people more fully. . . .

What training should manufacturers or importers provide? The local dealers should be able to have both their sales and service staff properly trained by the supplying company. They in turn should be in a position to pass the information down the line. This training should follow the normal maintenance, operational and service manuals provided by the manufacturers. (See translated instruction A and B which were produced by the South African Sugar Association from the tractor handbooks, and used

as instruction material and given to all literate drivers).

What assistance [does the] Government need? The backing and pushing by both suppliers and users of machinery to get on with the job, with the suppliers supplying the basic instructional material and the users using their influence to emphasise the need for action.

Who should receive training? First the suppliers, Second their instructors, thirdly the owners and fourthly the operators.

Where should the training be given? For Operators: In the first instance on the farms. Groups of drivers (10-15) should be brought to a central farm. As the idea of training becomes more acceptable to all concerned, centralised schools could be established.

Once he has acquired his drivers license or that level of competency, then periodic refresher courses should be held, lasting from 3 to 5 days and repeated every 9-12 months; and scaled upwards as his knowledge increases, until he [trainee] reaches the desirable level.

What language should be used? Can English be Used? In South Africa, the native language should be used for the drivers. The instructors can be taught in English.

What type of written material should be prepared? See enclosed material. [Simple manuals on tractor servicing written in the native language.]

How many people need to be trained by category? In South Africa we should train about 10,000 per year to catch up.

What makes the best visual aids? Actual objects.

Do Government farmer training or vocational training schools now exist where tractor operators, etc. can be trained? Limited, but a lot of plans are in progress for this to be extended.

Should purchases of machinery by governments include a certain per cent to cover costs of training? Yes.

When is the best time of the year to give training? During the slack period, e.g. in the sugar industry-- during the off-season i.e. when harvesting is not in progress.



How should a training programme be conducted? In a garage, with benches, boards, visual aids, etc. set up with the tractor in the foreground and all the tools, etc. neatly and correctly arranged. I feel it is best to place the trainee in an atmosphere with which he is acquainted and feels at home. Practical work is done in the garage and outside when driving.

Agricultural Engineering Basic Training in Africa

In a special study made in Africa for FAO, Boshoff Corbett emphasized that for any practical courses it is important to limit classroom instruction to that necessary for the trainee to understand what he is doing. For tractor operators, typical class instruction involving explanations from diagrams and taking notes, should be kept minimal (Boshoff and Corbett, 1965).

Davis, in 1954 suggested a syllabus for a novice operator's course, lasting four weeks in which 25 hours are devoted to lectures and demonstrations, and 110 hours to practical and field work. He suggested breaking the schedule into distinct phases and periodically assessing the trainees' progress (Davis, 1954-64).

In their report, Boshoff and Corbett (1965) also stressed in both general and option courses the instructors must see that time devoted to practical work in the workshop or field is spent in the most useful way. This means having the trainees carry out the operations themselves, rather than watching it being done. Similarly, periodic assessment of each trainee's progress can be obtained by

aring test cards to test the individual accomplishments and attainment of the training objective.

In their conclusions and recommendations for tractor and machine operators, Boshoff and Corbett (5, pp. 24-25) state:

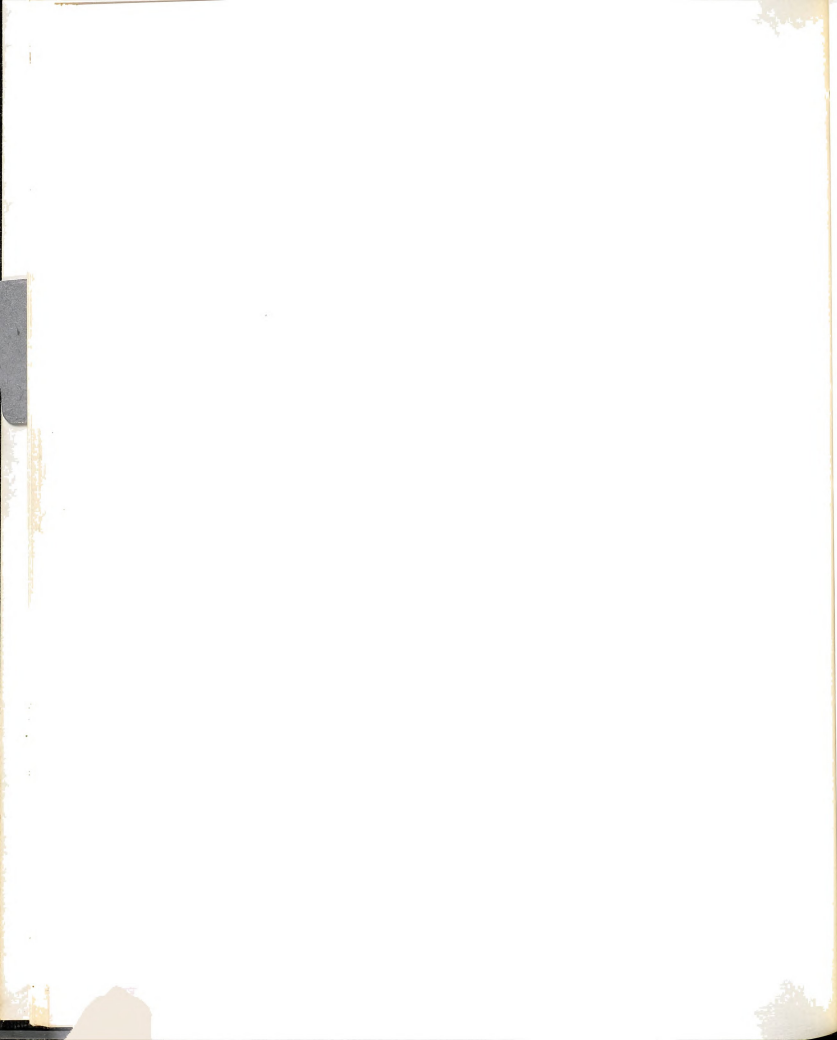
Courses for novice tractor drivers over two months long should be reviewed to cut out non-essential material. . . . More emphasis should be given to provide short refresher or improvement courses for tractor drivers. . . . In-service, or on-the-job training should be used as much as possible. . . . High priority should be given to supervisor and instructor training. . . . Tractor and machinery manufacturers should be encouraged to assist in instructor training and to provide relevant instructional aids in the local language. More attention should be paid to training local instructors who give ad hoc and regular courses in machinery operation at the Farmer Training Centres and Farm Institutes.

Some Current Training Programs for Accelerated Development

Training Programs of U.N. Agencies

The Food and Agricultural Organization (FAO)

e.--Downing (1970) reported that FAO is currently doing very little in direct training projects. While most training is incidental to special fund projects, FAO is cooperating with a farm machinery manufacturer at a training center at Buga, Columbia and with the Tunisian government at a school outside Tunis. There are 100 students per class at the Columbian school where training is six months. They graduate primarily supervisors and mechanics who agree to return to their local communities



to train farmers and extension agents. About 40 per cent of the students come from other Latin American areas but the majority come from Venezuela, Ecuador and Peru. This program is part of a larger training scheme called SENA which covers all basic vocational skills.

The training school at Majes Al Bab near Tunis has been operating for 10 years after being initially supported by an United Nations Development Project (UNDP). Specializing in agricultural mechanization of semi-arid and irrigated lands of North Africa, it has concentrated on training supervisors and extension agents to work more effectively with farmers. Basic tractor operator training has been taught but the content of the program and number of graduates were not available.

International Labor Organization (ILO) Geneva.--

The ILO is also concerned about the need for improved systems of training to produce qualified workers for industry and agriculture (Charles, 1969). They are cooperating with many regional organizations, such as the East Africa Community headquartered in Arusha, Tanzania, and the Economic Commission for Africa and the Organization for African Unity, both headquartered in Addis Ababa, Ethiopia. To prevent the concentration of industry and technical skills in the capitals and strategic areas, such as seaports and railheads, the ILO is trying to develop rural industries that can train local people

without skills. They recognize that training minimally educated people is a difficult job requiring special techniques and a different approach to training than is generally followed in most developed countries.

Training Interests of Regional Organizations

The Organization for African Unity (OAU), the East African Community (EAC), and the Economic Commission for Africa (ECA).--These groups all encourage public and private investment in education and training programs. Working with the World Bank, the Bank for Reconstruction and Development, Agridev (Israeli), Canadian External Aid, the U.S. Agency for International Development and similar technical assistance programs, these coordinating organizations foster regional cooperation and encourage participation by member nations. They normally do not operate any kind of training programs except to fulfill their staff needs. They act as clearing houses for information and work with officials in the various planning and policy-making levels of government in cooperating countries, including donor and receiver. In turn they request and receive help from the larger UN agencies such as FAO, ILO, and UNESCO, and from other bodies, such as, The International Bank for Reconstruction and Development (The International Bank . . . 1966).

The Asian Productivity Organization (APO).--Acting

on a multilateral basis to strengthen and improve their national productivity, several Asian governments established the APO in May, 1961. Originally focusing on all sectors of the national economy, the APO has also included agriculture in its programs since 1966. Close coordination is maintained between the productivity policy followed by APO and the National Productivity Organizations and economic development program of each country. Since 1969 two themes have been promoted annually in management and technology, with 1970 designated as the Asian Productivity Year.

Over-all objectives of APO are (1) establishing linkage between productivity and economic planning, (2) hastening and strengthening the productivity movement in the entire region, (3) fostering mutual help, (4) dissemination of knowledge, and (5) assisting national organizations' activities. To accomplish these objectives, APO organizes study missions, dispatches technical experts, conducts training meetings, supports seminars in member countries, undertakes research and maintains information activities.

The APO recognizes that education and technical-vocational training is one of the major limiting factors preventing faster and greater economic and social development. The rapid trend to engine-powered agriculture forces these countries to re-assess their long-range plans

and to find new ways of developing human skills and utilizing the natural resources of the nation.

Present membership of APO includes the governments of Ceylon, Republic of China, Hong Kong, India, Indonesia, Iran, Japan, Republic of Korea, Nepal, Pakistan, the Philippines, Thailand and the Republic of Vietnam.

Membership is open to all Asian countries who are members of the Economic Commission for Asia and the Far East (APO Expert Group Meeting on Agricultural . . . , 1968).

The Central Treaty Organization (CENTO).--This coordinating and educational body has supported practical training and agricultural development since its inception to assist Iran, Turkey and Pakistan. In 1966 a special seminar traveled throughout the region and made these observations about training for the introduction and use of farm implements and power units in CENTO (1968, p. 147) countries:

1. Farmer training is needed in machinery application, operation, maintenance and simple repairs;
2. Facilities for farmer training are both lacking and deficient;
3. The most efficient way to reduce maintenance and repair costs is to use well-trained and careful operators;
4. Investment in training is one of the least costly inputs of increased economic agricultural production;
5. There is a paucity of manuals, teaching aids and publications in languages and forms understood by the illiterate or foreign-language farmer;
6. Very few training programs start at the farmer's or trainee's level and consider his traditional

non-mechanical background and lack of disciplined training;

7. Present extension workers need practical in-service training on the selection, application and maintenance of farm implements and power units;

8. Courses in vocational and technical schools should be reviewed and the unnecessary theoretical material replaced with practical information and skills related to farmers needs;

9. Establish farmers and contractors schools dealing with the problems and practical aspects of using, managing and caring for production farm machinery;

10. A comprehensive training program on the use, operation and maintenance of farm machinery purchased under loan should be required in any agreement to purchase;

11. Farm machinery importers and distributors should be encouraged to offer a course on machinery operation and management lasting a minimum of one to two weeks to any purchaser.

Training by Private and Semi-private Groups

Gezira Irrigation Scheme (Sudan).--In North Africa,

Phothecary (1967, p. 63) states that:

the Agricultural Engineer in collaboration with other authorities, should plan and direct specialist training facilities for managerial staff, supervisors, agricultural mechanics and tractor drivers. This field is of fundamental and vital importance to any mechanization programme. Although there are many born operators, the complexity of the tractor driver's job soon reaches the stage where formal training pays off. Properly trained agricultural mechanics are equally essential. . . . As mentioned earlier, properly trained supervisors and managerial staff are a basic necessity and the relative absence of training facilities for this class of personnel is a feature not only of the Sudan but of many other countries. It may be argued that training facilities exist in advanced countries for this class of personnel, but quite often the prevailing conditions there are very different from those encountered in the trainee's country of origin. (Underlining by author)

South African Sugar Association.--These notes are for the guidance of instructors when giving a three-day refresher tractor driver training course. They are read in conjunction with the syllabus and the program schedule. Booysen, (1969, pp. 1-12) makes these candid comments to new instructors. (Underlining by author)

The Objective. To take existing tractor drivers and convert them into RELIABLE and CONSCIENTIOUS OPERATORS who have to possess a POSITIVE ATTITUDE towards the work.

- METHODS
1. Cast out the NEGATIVE ATTITUDE men and those with NO CONCEPT OF MECHANICS, ruthlessly.
 2. Use the TRAINING SYLLABUS well to develop and guide the remainder towards the objective.

SERIAL NO. 1: "WELCOME AND ADMINISTRATION" This is the opening of the course. The senior instructor or his deputy will do the welcoming of the students to the course. He will explain to them the reason why they have been sent on the course, why they are important people to the Sugar Industry, why it is important they know how to drive a tractor and why they should know how to maintain the tractor properly.

He may include further reference to the importance of the role which the tractor driver plays in the agricultural business. The tractor drivers must at all times be encouraged to feel that they are important, that if they do their job properly they are helping their employers to earn more money and consequently they can expect to earn more themselves.

...

SERIAL NO. 2: "DAILY MAINTENANCE" This period is done by the students under the guidance . . . instructors must be wide awake to see that everybody gets a chance at going over the tractor. There is half an hour allocated to this period and you will find that the keen drivers will jump onto the tractor and do all the work, whereas the lazy man will just stand behind and look on. The lazy man is the man you want to catch to do it, because he may think he knows it but in actual fact he does not. . . .

SERIAL NO. 8: "PRACTICAL DRIVING: THREE POINT"

Instructors must be alert at all times to the fact that students get bored very quickly unless they are occupied. During these practical driving and skill tests it happens all too often that the instructor is busy with one man on the tractor and the rest of the class has to stand round or sit around doing absolutely nothing. The instructor must organize his class in such a manner that while he is busy checking one man on a tractor the others are occupied. You can do this very easily when you have more than one tractor on the site. You give the other group a chance to carry out their practical work. You explain to them that whilst they are not being called out by you to do certain jobs they are free to get onto the other tractors, to drive and test their own ability. . . . You will find that they will probably enjoy this because they are free from your supervision, they're amongst themselves, maybe joking and laughing, but at the same time they'll be doing a job of work and keeping themselves busy. Encourage them to change over often so that everybody gets a chance to get on the tractor before he comes to you for testing or checking on his ability to do what he claims he is able to do. THIS IS MOST IMPORTANT. UNDER NO CIRCUMSTANCES MUST ONLY PART OF CLASS EVER BE OCCUPIED AND THE REMAINDER SIT AROUND DOING NOTHING. . . .

SERIAL NUMBER 3: "SUMMARY OF THE COURSE" . . .

Your course finally closes down by having an hour of final maintenance and clean up. This is a full hour and it is essential, as it is most important, that all equipment used on the course must be returned to their owners in tip top condition. There is no point in teaching drivers how to look after their tractors well and then allow them to go home with dirty tractors, badly serviced. All equipment must be checked and must be shining and clean. This is one of the most important periods of the course. . . . When summarising, as at the end of Day 1 and Day 2, called revision, it will take the form of a run-through of the complete syllabus. No questions will be asked of students. If students ask questions they must be answered, of course, but they must not lead to another lecture or talk. . . . When you have finished that part of the programme your course is virtually at an end except that as the instructor, you will say thank you to the class for having attended, thank you to them for having listened, thank you to them for having been prepared to learn.

Training Assisted by the Farm
Equipment Industry

South American Farm Mechanization Training Centre.--

In November 1967 the South American Farm Mechanization Training Centre (SAFMTC) was established at Buga, Columbia, under an agreement between a Columbian Government agency, Servicio Nacional de Aprendizaje (SENA), the Massey-Ferguson Company (MF) and the Food and Agriculture Organization of the United Nations (FAO). SENA assumed overall responsibility for the Centre while MF consigned instructional staff and equipment to FAO's "Freedom From Hunger" campaign.

The project is designed to help Latin America overcome major problems in the shortage of skilled agricultural mechanization technicians. Attempting to fill this gap, the Centre is training candidates from Latin America who, upon return home, will serve as instructors in farm mechanization, as supervisors on agricultural development projects or as government farm machinery extension officers.

Dr. Carlos Lleras Restrepo (MF View, 1968, p. 7), President of the Republic of Columbia said, "It is not enough to bring machines into the fields. The farmers must know how to use and maintain them. Much of our resources have been lost for want of proper training. Thus this centre will make a great contribution to the economy of this and other countries."

To provide the training, large numbers of instructors in agricultural machinery operation and maintenance will be required. Lars Stenstrom (MF View, 1968, p. 7) with FAO said, "the three parties contributing to this project have clearly seen the importance of training and FAO is most gratified that SENA and MF have dared to embark on a scheme so untraditional."

Operating at full capacity, the Centre can house and teach 500 students at one time in a variety of specialized courses in mechanization. Trainees are chosen on the basis of recommendations received from South American Government departments or educational institutions.

In a 1970 Progress Report for the second quarter, Siertsema (1970) project manager of SAFMTC reported that 60 candidates will be enrolled for the second semester. In the 1970 first semester courses, of the 23 students who finished the course on Operation, 17 received certificates as Supervisor/Instructor, 4 as Operators, and 2 Certificates of Attendance. Twenty-eight students completed the course on Repair with 12 awarded certificates as Supervisor/Instructor, 7 as Mechanics, and 8 Certificates of Attendance.

Special short courses on the operation and repair of machinery were offered in addition to the regular residence courses. Three groups (82 specialists) attended one-week courses in June 1970 covering Information on Operation of Tractors and Machinery. Another group of 15

officials took part in a seven-day course on Instruction on Operation, Maintenance and Repair of Combines. Siertsema (1970, p. 6) says they are more convinced that "The theoretical instruction is going to have [to have] a more practical nature."

A summary of the course, student and instructor hours for the 1970 Semester I courses showed that the Operation and Maintenance Course required 880 class hours and 1600 instructors hours with an average of 12.65 student hours per instructor hours. The Repair Course took 1010 class hours and 3044 instructor hours for an average ratio of 9.29 student to instructor hours, indicating the higher cost of detailed supervision. The overall average student to instructor hours was 10.82, including non-scheduled courses which had a student to instructor ratio of 17.80 hours (Siertsema, 1970, p. 7).

African Operator and Management Training Centres.--

Attempts are underway to gain support for the operator and management training centres at various African locations. These centres want to train African operators and managers for small and large holdings, but too many things must be taught. Thus a real struggle for financing and survival exists. The end result has been the teaching of primary routine to tractor operators hoping they will meet the most simple functional demands for motive power operation.

Progressive design of modern tractors has reached the point where only elementary servicing is necessary; but all advanced servicing must be undertaken by well-equipped shops manned by factory or local technically-trained personnel. In the training schools, Denike (1969, p. 43) reports "management factors are essentially given only the lightest brushover because most students have not progressed beyond Grade 4 or 5 in elementary schooling and could not assimilate anything beyond the most simple recordings." Furthermore he points out most students are encouraged to return to their native zones and "the normal wage for a trained and skilled operator is one shilling (14 Canadian cents) per day . . . something for social and economic experts to cogitate upon."

Graduates are trained to perform the daily, weekly and periodic services on tractors and/or tractor-drawn farm tools. An effort is made to impress the students with the grave responsibility they carry when vested with the "care and feeding" of important farm tools. They are trained in simple and essential skills with respect to maintenance--soldering, flame welding, some arc welding, metal shaping, care and use of fuels, lubricants, and greases, inflation of tires for traction and/or loading--and many other basic service functions.

Denike (1969, p. 43) observes, "It becomes abundantly evident that these schools are well-intended, the

staff management and trustees motivated by the most worthy and sincere desires--but 30 years out of date and two generations ahead of their time!" The cost-effectiveness of these schools is very low because they spend one to three years teaching a course which can be completed in four to eight weeks. Performance testing is not used and no one can certify for sure that learning has actually taken place, that the trainee will actually practice his new ability and that it measures up to a definite set of standards.

Systems Engineering Applied to Instructional Design and Testing

The Systems Approach to Training Design

The systems approach is being used and misused with increasing frequency from solving missile problems to developing better educational processes. In education researchers have devoted attention to the learning process, but primarily on a theoretical basis. Lee (1970) reviews several instructional systems models for the application of the systems approach to education.

Gagne (1962) offers a system, with the human factors track having three major parts--the design, the development, and the testing stages. Before preceding with the design the purpose of the system must be defined. Included in the design stage are task description, task analysis and job design. The development stage includes job aids,



personnel selection and classification, individual training, training devices and performance measures. Team training precedes the testing stage, followed by systems training, system evaluation and finally system operation.

Smith (1965-66) goes on to apply the system approach to the feedback function and comes up with the following important steps in a quality control sub-system: a detailed statement of training objectives based on job requirements, accurate and appropriate proficiency measures, effective communication concerning the performance of students in tests, effective procedure for any corrective action and supervisory support. Smith's system emphasizes the student, performance, knowledge, student management and quality control.

Eraut (1967) demonstrates the relevance of the systems approach to the instructional design process, particularly in course development. He views a course as an instructional system--the learners, instructors, materials, machines and technicians. Input is the learner's initial knowledge, and output is the learner's final knowledge and skills. Attitudes are not emphasized.

Kaufman (1968) includes the following steps in the systems approach: define "what is," and "what is required;" select an appropriate process for achieving "what is required;" implement the process; determine the validity of solution; and re-do if necessary. In order to synthesize

a system using these steps, additional major-level tasks must be performed: select and implement solution strategy, determine performance effectiveness and revise the system as necessary.

Lave and Kyle (1968) acknowledge the nine steps of their model--goals, scope, objective function, conceptual framework, analysis model, measurement model, testing, alternative solutions and implementation--need not occur in the order stated, nor be performed independently.

Lehman (1968) suggests that the systems approach to education consists of eight steps: need, objectives, constraints, alternatives, selection, implementation, evaluation and modification.

Merrill (1968) treats the final task of revising as the most distinctive feature of the systems approach. Major components of his system are the learner, the environment and the instruction. Inputs to the system environment include learner traits, all instructional materials, objectives and feedback; outputs are knowledge of results, response record and display to the learner.

A relatively new system component termed "presentation form" was suggested by Tosti and Ball (1969). They state "Presentation form is designed to be independent of media and content so that media forms may be paired to educational requirements and theories in a rigorous



anner." Failure to recognize the distinction between the design elements of medium, presentation form and content is the major fault of instructional design today.

Instructional Design Considerations

Unfortunately, the trend in higher education has shifted from teaching teachers how to teach toward greater subject matter competency. An individual is hired at the college level on the basis of an advanced degree in a specialty, with little thought given to his teaching effectiveness, psychological and philosophical outlook. The need for human understanding and a philosophy of knowledge as a factual basis for presenting scientific or philosophical ideas still exists.

The systems approach ascertains what the instructor has to teach and helps him achieve those goals through various methods and media at his command. In addition to knowing purely engineering aspects, the instructor must focus on the human element in adopting a process for each particular problem. Gilpin (1962) suggests some humanizing influences. The relevant capabilities of the particular student group must be known and specified in the same manner as the instructional behavioral objectives; measuring instruments are needed to detect entering students who do not have the necessary capabilities; relevant capabilities (such as physical defects) must also be identified; and the practical aspects of facilities,

personnel, equipment, and maximum training time must be considered. Gilpin (1962) adds: "These things all have to be specified exhaustively so that the instructional system designer can know both what resources he has and the limitations within which he must work."

The philosophic approach is pointed out by Churchman (1965), who uses the term "housekeeping approach" to characterize the part-to-whole method of system design as opposed to the whole-to-whole system principle which examines the problem for whole costs and benefits. According to Churchman (1965), "The good system designer is one who listens carefully to the debate between these two sound principles."

Psychological bases of instructional systems design are suggested by Glaser (1966). Although the basic design components of analyzing the characteristics of subject-matter competence, diagnosing pre-instructional behavior, carrying out the instructional process and measuring learning outcomes are similar in most design approaches, their implementation differs. For example, in analyzing the characteristics of subject-matter competence, Glaser (1966) states "the instructional designer would do so in terms of the stimulus characteristics of the content, the properties of the responses the students make to the content, and the structure characteristics of the appropriate domain--probably in terms of its conceptual hierarchies and operating rules."

Prior to any attempt to implement the system approach, the instructional designer and systems user should realize there may be several systems or approaches that will work. Each must decide what he wants the system to do; and select, adapt or produce a new system that will best do the job, with adequate consideration for all cost-benefit factors involved.

Systems Model for Curriculum Design

A systems approach is a rational, problem-solving method of analyzing the educational process and making it more effective. The educational system includes students, teachers, the curriculum content, the instructional materials, the instructional strategy, the physical environment and the evaluation of system instructional objectives, learner's performance and program effectiveness. Educational effectiveness is defined and tested in terms of desired changes in student behavior. To be effective Cyrus and Lowenthal (1970, p. 16) emphasize that these changes will be achieved within the context of minimal cost and feasible allocation of resources without imposing unacceptable limitations on any other elements within the total system."

Systems analysis can increase educational effectiveness by clearly stating desired behavioral objectives, and designing the total learning process to ensure student or trainee attainment of these objectives. The curriculum

Objectives must be stated in terms of anticipated change in learner behavior so the trainee and the teacher both know exactly what is expected at the end of the course. Purpose becomes operational only when specified as desired behavioral changes in skills, attitudes, knowledge and student values.

More accurate trainee evaluation can take place when trainees are assured that all tests will reflect the skills, knowledge and concepts developed in the course. When reworded, clearly written behavioral objectives actually become test items. Furthermore, the most suitable instructional materials and teaching strategies can be selected to achieve the stated objectives.

Cyrs and Lowenthal's (1970, p. 17) flow chart, similar to Figure 2.1, illustrates the "Strategic Areas of the Systems Approach to a Total Curriculum Design." The elements of the chart are briefly described as follows:

No. 1. Gather input data on students. What is known about the population of students or trainees? New tests should be developed to supplement information provided by currently standardized tests and school records. Tests results enable course designers to realistically establish skill attitudes and knowledge levels.

No. 2. Formulate student performance objectives. All lesson, unit and course objectives must be stated in terms of individual performance. The student must know what is expected of him and how he will be evaluated. The objectives concentrate on skill development in listening, speaking and viewing (if trainees are low level or illiterate), reading and writing (if students possess these basic tools); on knowledge of thematic concepts developed, as Cyrs and Lowenthal (1970, p. 18) puts it, on "self-identity,



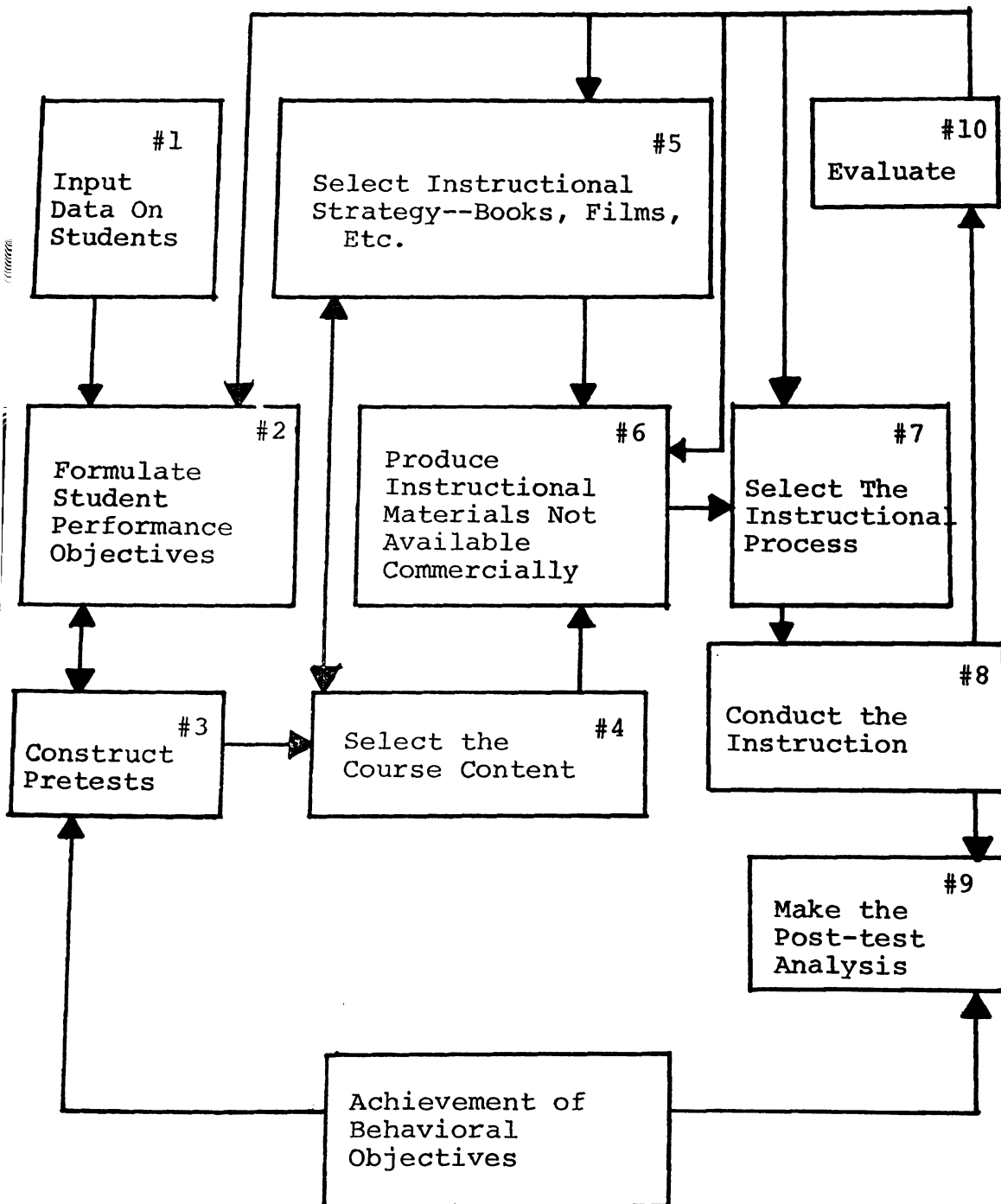


Figure 2.1.--Strategic Areas in the Systems Approach to Total Curriculum Design (after Cyrs and Lowenthal).



the family, the family of man, the hero and the future." However, they do not mention change in attitudes as a separate goal--a crucial task when working with disadvantaged and low-education trainees.

No. 3. Construct pretests. Each student should be pre-tested to determine how well he already knows lesson objectives. Proper pre-tests permit teachers to diagnose learning requirements and the instructional package needed to achieve course objectives.

No. 4. Select course content. Select course content after the objectives have been clearly determined. Content is judged in terms of helping the student or trainee attain the objectives.

No. 5. Select the instructional strategy. Once content has been selected, media most appropriate for its presentation are chosen. For low-education trainees, this would consist of objects supplemented by pictures, charts and possibly slides. More sophisticated education and training systems might use printed materials, books, films, audiotapes, programmed texts and other audiovisual media.

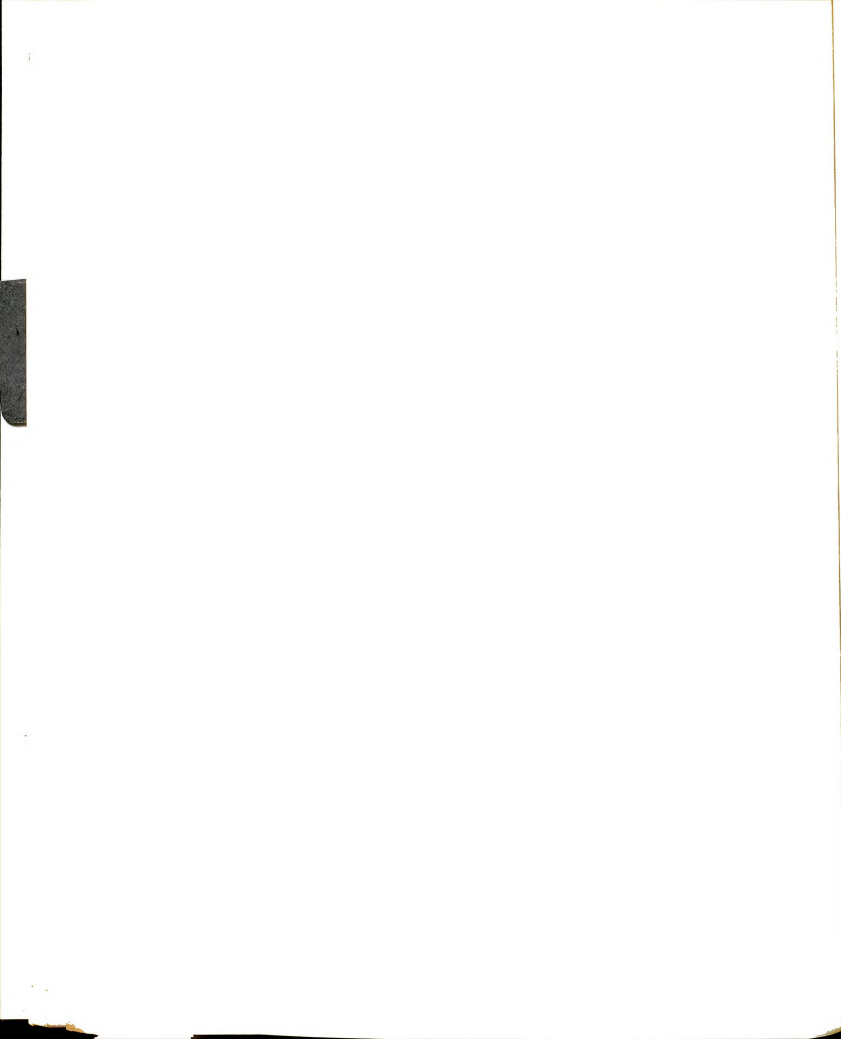
No. 6. Produce instructional materials not available commercially (or economically). Many instructional materials commercially available cannot be used in specific teaching objectives. In larger schools and training centers, a media production and duplication center should be established to help develop the materials necessary to achieve instructional objectives.

No. 7. Select the instructional process. The most effective instructional processes are chosen for the learning environment such as large group instruction, small group activities and individual instruction and investigation.

No. 8. Conduct instruction. The new teacher role is to develop an adequate learning environment, diagnose learning problems, prescribe the best learning sequences, conduct effective small group activities, and assist trainees in individual conferences.

No. 9. Analyze post-test. After completion of the instructional units and consultation with the teacher, the student is tested. If a significant gain between pre-and post-test scores was achieved he proceeds to the next learning experience.

No. 10. Evaluate. Every phase will be evaluated so more effective procedures and strategies can be developed. Constant evaluation is the key element in the learning process. It provides the necessary data to revise the course, the unit and lesson objectives--



through interviews, attitude surveys, questionnaires and direct observation.

Pre-test each student before beginning a study unit. Based on his score, one of several learning packages of different difficulty levels can be selected for him. Each package will tell the student what to expect, and provide the sequence he will follow to meet the stated goals. Post-tests will help determine achievement and whether the trainee is ready for the next lesson. In difficult cases the teacher will prescribe alternative learning sequences and help individual students. Cyrs and Lowenthal (1970, p. 18) suggest that "initially the student will spend about 50% of his time working individually or with a partner on the packet materials. The remainder of class time will be devoted to large group instruction and small group interaction."

Redesign of Army Training Programs by Systems Engineering

Of all the training organizations, probably none has as great a task as that undertaken annually by the United States Armed Forces. The U.S. Army has a vast and complex establishment whose sole job is to train recruits as well as experienced soldiers in the art and science of modern peace-keeping and warfare technology through continuous manpower development. The U.S. Army training establishment consists of 45 agencies that conduct over 100 courses. These range in length from one to 40 weeks

d have a total average daily attendance of over 200,000 students. The army, like other groups concerned with training is constantly reviewing its policies, procedures, rationale and results. As a consequence of an intensive investigation since World War II, the U.S. Army decided some major changes were needed. In February 1968, the Continental Army Command issued a 108-page regulation titled "Systems Engineering of Training (Course Design)." This has become the "Bible" for training policy and requires all Army Service Schools to redesign their training courses according to these new concepts by 1973.

A recent article by Sherrill (1970) describes how the Adjutant General School, located at Fort Benjamin Harrison, Indiana, is converting its training by the Systems Engineering Approach. A single example is used to show the basic steps needed to train enlisted personnel to perform as "personnel specialists." This represents over 260 hours of redesigned training now more effectively administered and controlled. All training is aimed at qualifying individuals at a particular entry level in a Military Occupational Specialty (MOS).

Job Identification.--"Job identification" according

Sherrill (1970, p. 43):

is to describe the particular MOS in terms of typical organizations to which job incumbents are assigned, various job titles applied, major job functions performed, typical internal organizations, areas of specialization, major Army systems supported by the job incumbents, relevant official publications, and



other similar information. The purpose is to establish a framework within which subsequent training decisions can be made.

Task Inventory.--Training analysis team, normally composed of one job analyst and two persons with job experience, prepares a "task inventory" of the MOS being studied. Usually four or five inventory drafts are made before the analysis team is satisfied it is comprehensive and well organized. Next, personnel with on-the-job experience look for ambiguous task statements and tasks omitted. If much feedback is received, the inventory is reworked and checked again by a second group for clarity and omissions. No attempt, however, is made to limit the coverage of the inventory. The function of the task inventory is to describe all of the possibilities as nearly as possible, without describing what should be.

Job Data Collection.--After review and revision, the task inventory is incorporated into a "checklist-task inventory questionnaire." A pre-test of the questionnaire is made on a small sample of personnel with actual job experience to ensure it can be administered.

Below are listed one part of the 24 major work activity areas identified in a task inventory for one MOS. This particular area covers the "enlisted evaluation system" which annually tests eligible Army enlisted personnel (EP) in their occupational specialties. About 100,000 EP are tested annually in their primary MOS for

different MOS's; they are tested in their secondary every other year. Administering the monthly EP evaluation system is a major work function of personnel specialists. The numbers show the percentage of specialists performing each task.

1. Determine number of personnel eligible for testing	27 per cent
2. Requisition test aids	26 per cent
3. Distribute test aids	26 per cent
4. Initiate Commanders Evaluation Reports (CER)	36 per cent
5. Forward CER for completion	37 per cent
6. Check CER for proper completion	34 per cent
7. Prepare MOS test roster	23 per cent
8. Forward MOS test rosters and CER to Test Control Officer	28 per cent
9. Coordinate time and place of testing	22 per cent
10. Process requests for regular and special make-up testing	23 per cent
11. Distribute test results	26 per cent
12. Determine eligibility for award or retention, or necessity of withdrawal of proficiency pay	30 per cent
13. Solicit recommendation for award or retention of proficiency pay from commanders	23 per cent
14. Prepare request for orders	25 per cent
15. Initiate yearly reclassification action if required (to include board action).	20 per cent

Selection of Curricula.--After collecting job data,

isions are made about training content. Normally these
isions are made at levels of work activity above the
statement. The data above, for example, suggest
at one fourth of the typical job holders work in the
a of the EP evaluation system. Sherrill (1970, pp.
(6) says:



that 77 per cent of the job incumbents performed one or more of the tasks in this work activity area . . . few personnel specialists performed all of the tasks related to the enlisted evaluation system; however, most of them performed at least one and usually several of the related tasks . . . supervisors indicated they expended significant effort in supervising the enlisted evaluation system and that errors were frequent.

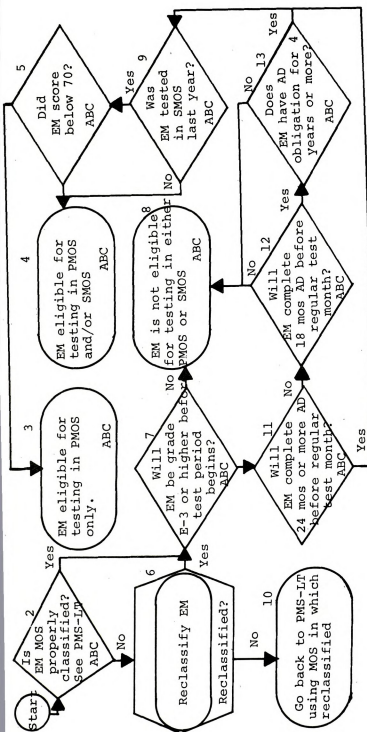
Since this system has a major impact upon morale, pay and efficient use of EP skills, the decision was made to include training on the EP evaluation system in the personnel specialist course.

Task and Skill Analysis (TASA).--TASA has two basic purposes--to identify the specific tasks within the work activity area to be trained and to describe how each task is performed. This attempt to structure and organize the work activity requires one of the largest investments of effort. In this analysis, new tasks may emerge and previously listed inventory tasks may be dropped. As a result, a job model is derived from an incomplete description. Work activity must be defined in a way that is observable and measurable while in the analysis, primary consideration is focused on transferring the training to the job and realism.

While employing traditional analytical tools, the Adjutant General School has increasingly used the "logic tree" to perform the TASA.

Figure 2.2 illustrates one part of the seven logic trees constructed for each task of the personnel specialist





Task: To identify personnel eligible for testing under the Enlisted Evaluation System Conditions/Clues: Receipt of DA Circular announcing tests and access to Enlisted Qualification Records (DA Forms 20).

Note: A, B, and/or C inside each block denotes alternate test version in which that element is to be evaluated

^aSource: Audiovisual Instruction, January 1970, p. 84 (PMS-IT-1a, 21 Nov. 1968)

Figure 2.2.--Sub-routine of Logic Tree Used to Determine Enlisted Eligibility Criteria for MOS Testing (After Sherrill).^a

identified by the TASA. External initiating and terminating cues determine where to start and stop a logic tree. Furthermore they define the boundaries of each task (the grouping of skills, knowledges, discriminations and determinations). The task is internally comprised of decisions and discriminations an employee must make. He must generate the stimuli and responses that lead to completion of the task. Sherrill (1970, p. 44) reports, "of the seven tasks identified for training in this work activity area, the number of blocks on each logic tree range from a low of 19 to a high of 97. Thus, no task is equal in size to any other task, yet each task is described at about the same level of specificity."

Criterion Design.--In designing criteria, the task is described and all possible job versions of each task are identified through the various paths within the logic tree. The training analyst develops a measure for each task to indicate whether the training has produced the desired results. Examination of the logic tree reveals many combinations of test questions and problems. The basic task is to design a measurement instrument that will confront the learner with a realistic approximation of the entire task as defined by the logic tree or job model. Further, the results of the test must be specifically related to each block on the logic tree.

The aim in test design is to secure a record of each student's performance related to each "task element" (the decisions, discriminations, etc., identified with the task and skill analysis). The simplest way is to have the student provide it. The interplay of the demands for test realism, and the enormous amount of data processed demand that the test allow the students to provide a machine scorable record. This is ideal but many courses, such as the Basic Tractor Operator's Course, require the instructor to observe each student on all machines and record his performance on every test element. If the classes are large, the data can be recorded on specially printed punched cards to permit machine scoring and analysis.

Special answer sheets can be designed to facilitate test scoring. They should not give unnecessary cues or compromise job realities. The test must present realistic problems and give the learner the tools normally available on the job. Before new training is developed, the designer should prepare a critique of the new test to be used by the instructors, in addition to designing the test instrument. In this pretest the instructor can identify the performance elements most frequently missed through the critique key, and direct his critique and reteaching at the most important problem areas.

Design of the Training.--The bulk of the analysis is performed by organizational elements independent of the instructional system. At this point, the completed logic tree, the critique materials and one version of the criterion test are turned over to the cadre responsible for conducting training. In the army system, Sherrill (1970, p. 86) says:

The instructors are asked to prepare training that represents their best estimate of what is minimally required in the way of learning experiences for their students to perform adequately on the other version of the criterion text which is not shown to them. . . . After the instructional personnel have designed a unit of instruction aimed at each criterion, the new training is implemented, initially on a trial basis with the first available class.

Training Quality Control.--After the first revised course is completed, students are given the new tests. No major problems are encountered in taking the test, maximum time is selected which will allow most students to complete the test.

Little has been said about the design of the training. Sherrill (1970, pp. 86-87) says that:

In contrast to traditional practice this area has become relatively less important. For over four years the school has attempted to design training materials that would produce the desired results but has uniformly been unsuccessful. Even with the most careful selection of instructional strategies, instructional materials, method and media, it has repeatedly been demonstrated that optimum instructional design cannot be reached until after several training cycles have been completed and the results (as obtained from the criterion test) have been fed back into the training. Initially, considerable effort went into the training design. Even though

considerable effort continues to be made, any time a new criterion instrument is introduced into a particular course, there is now the general acceptance that several classes will have to be completed before the training approaches a desirable quality.

As the school continues to apply the rationale of training design described in this paper to more and more instructional areas, the training quality control step continues to assume a more significant part of the entire process. . . . The most powerful tool within the training quality control system is the misrate for each element of performance, or in this case the misrate for each particular test item. The identification of weakness with the instructional design is quite specific. There is no question as to where emphasis and practice . . . should be directed in subsequent revisions of the training.

This type of training design is often vulnerable to rote learning. Sherrill (1970, p. 87) says:

There is a real tendency on the part of instructional personnel under the pressure to produce students who can perform successfully, to attempt to teach the process by rote. The effective counter to this problem is the random use of alternate test versions from class to class. Since both test versions require application of the same principles and the same decisions and discriminations but with different cases, the instructional personnel quickly learn that the only way to beat both test versions is to ensure that their students can perform on any possible given versions of the task through understanding rather than by rote.

Students also get the idea that a lot less effort will be required if they settle down and learn how to perform the task than if they attempt to beat the test. Since the design of the criterion test instrument is quite complex in comparison with traditional objective type tests, most of the problems of test compromise have ceased to exist.

Test results can be summarized so decisions concerning students--whether they pass, fail, need retraining or recycling--can be made. The basic analytical tool is called "frequency distribution." No attempt is made to

establish a standard of minimum required proficiency. Instead a standard, or pass/fail point, is established for each criterion test based on an inspection of the frequency distribution.

As performance improved on tests the pass/fail score also increased. Sherrill (1970, p. 88) states:

in fact, more confidence can be placed in the setting of the pass-fail point as the distribution of scores becomes more skewed. Those students who actually did not profit from the instruction became more obvious. At some point, usually between five and ten classes, the average performance on the test tends to level off. . . . At this time decisions are made regarding the accuracy of the standard in terms of the score representing sufficient competence for an individual to begin working in this area on the job.

Additional instructional resources can be added if the minimum score is too low, or they can be reduced if the score is higher than needed for entry proficiency.

Implications.--For manpower training the instructional design and management approach illustrated contrast with most present curricula development and evaluation practices. Sherrill (1970, p. 89) says the highlights are:

1. Both students and instructors respond favorably to these procedures. The contrast between new and old portions of a course are quite noticeable to students. Typically about half of a class will suggest in their written critique of the course, that all of the training be designed like the newly introduced portions of the training.

2. The classroom atmosphere is different. 'No students get sleepy.' The academic games played in lecture-centered courses of training are conspicuously absent. There is a dedication of purpose. The students and instructors form a partnership aimed towards achieving the same goals.

3. A major effort is invested in developing models and criteria before decisions are made on the time, method, media and instructional strategies. Absolute criteria are used to control the training design and conduct. Student achievement approaches a constant, and within limits, time becomes a variable.

4. Versions of the training rationale illustrated could be beneficially applied to public school and university curricula development and course conduct even though Army training courses are job-centered while public school and university curricula are life-centered. The rationale has direct application for more relevant teaching, effective learning and meaningful evaluation in all training programs.

Supportive Research to Improve Instructional Systems

There is much talk about the need for training tractor and machinery operators in developing countries and for manpower training in developed countries, but very little research has been conducted by educational institutions in this area. Most of the knowledge about training problems has been gathered by foreign experts working in developing countries, by farm machinery distributors and dealers serving in overseas sales programs and by the recent activity in manpower training of the tractor manufacturers. Some companies, like Caterpillar Tractor, have developed elaborate training programs for key people in local and foreign market areas, including heavy machinery operators who are literate. But they do not attempt to train the illiterate person.

The U.S. Army has developed training programs for operators of specialized road building, airport construction

and shop equipment. However, they deal with literates and stress know-how concerning the various parts and systems and their functions which are not appropriate for the minimally-educated farm-tractor operator. The questionable success of these training programs in prolonging the life of equipment or in preventing machinery breakdown indicates that a system of training is not yet available to do all it purports to do.

To develop the regional concept for training operators, the Massey-Ferguson Company helped establish a school for tractor and implement technicians at Buga, Columbia in cooperation with the Food and Agriculture Organization of the UN. (See page 62) Associated with FAO, this school is aiming at a higher level to train instructors and supervisors, workshop personnel, mechanics and senior government officials. Farmers, middle-school leavers and unskilled adults are not yet being trained at this school. It is not known how many or what types of actual operator training programs are being conducted. Instructors graduated from this school after they return home.

Estimating Student or Trainee Interest

One should not conclude that a student's skill performance on a final exam reveals any willingness on his part to apply this knowledge later on. At the end of a course, teachers should measure a student's

attitudes and feelings about a subject to get an indication of his future behavior. Yelon (1970, p. 34) says:

most teachers and psychologists have had relatively little success at clarifying expressions of affective processes. . . . How can we formulate a statement of an instructional objective that will include a valid estimate of students' interest and observable, related behavior that we can measure?

Yelon lists five major steps in this strategy similar to one used to determine whether a student has learned a concept: (1) specify behaviors, (2) state common attributes, (3) test working definitions, (4) choose school related behaviors, and (5) test objectives.

Figure 2.3 is a flowchart, similar to the U.S. Army logic tree, used by Yelon (1970, p. 35) to show the steps in this process. The first step (Box 1) lists behaviors believed to be expressions of student interest. The second step (Boxes 4-7) attributes common to these behaviors are stated to serve as a working definition of student interest.

During step three (Boxes 8-12) the definitions are examined by other teachers. The working definition is presented with examples of conforming behavior and non-conforming response. The teachers choose examples which they believe fit the definition. Then their responses are analyzed to see how many true and false examples were selected. When zero (no) answers are obtained the definition is refined until agreement is reached.

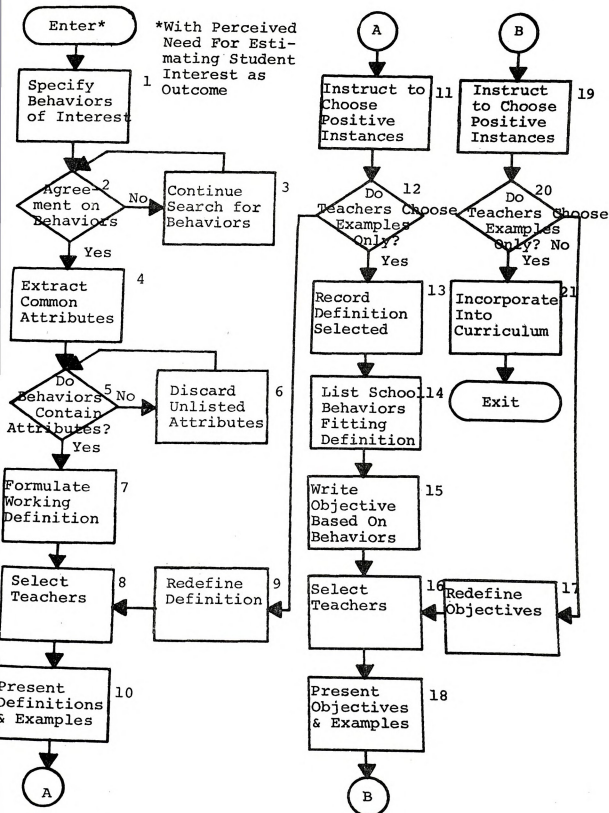


Figure 2.3.--Flow Chart: A Strategy for Estimating Student Interest. (After Yelon) Source: Audiovisual Instruction, Jan. 1970, p. 35.

In step four, behavior samples are looked for in the school, class, group and individual activities which conform to the definition (Box 14). These behaviors are used to create objectives in the subject in which they are found (Box 15). Student interest and on-going involvement can be shown by participation in at least two or more activities as part of a stated objective. For example the learner could express appreciation for preventative maintenance in two or more of these ways:

1. Perform daily pre-service checks on his tractor in the morning
2. Constantly check the tractor during operation for needed adjustments
3. Make after-operation checks at the completion of the days work
4. Study the owners manual to learn more about the care of the tractor
5. Ask mechanics and skilled technicians questions to increase his knowledge base

In step five the objective is verified in the same the working definition was refined. Once the activities that satisfy the objectives are agreed upon, the learner's performance is compared to determine the degree instructional outcome--how well was he motivated to try his learning after training was completed?

Functional Job and Task Analysis for Training Design

The importance of behavioral objectives has been emphasized for some time. If trainers want to structure jobs and develop a curriculum to train people for them, the jobs must be described in precise terms. The main objective of Jobs in Instructional Media Study (JIMS) (1970) was to analyze jobs in more precise terms and establish data which could be used to restructure and suggest training for those jobs.

JIMS discovered that jobs had to be broken down into tasks, and tasks are separate elements having a discrete beginning and end and which can be separated from other tasks. The second discovery was that tasks should be looked at from two directions--from what got done and from what the worker did. The statement "change crank case oil" does not tell enough about what the worker does. And if there is vagueness about what the worker needs to learn, there cannot be a specific curriculum. There must be some way to analyze a task from two points of view--what gets done and what the worker does.

Functional Job Analysis--Tasks can probably best be analyzed by trained specialists through direct observation of people as they perform the tasks in their jobs, instead of through questionnaires or checklists. This technique has been used by the U.S. Labor Department (1965)

since 1934 in conducting on-the-spot Functional Job Analysis.,

A modified form of Functional Job Analysis (FJA) was developed by Sidney Fine of the W.E. Upjohn Institute for Employment Research. Fine helped develop the original FJA while with the U.S. Labor Dept. The modified FJA as used by JIMS (1970, pp. 26-30) includes the following basic tenets:

1. First, all tasks are related to Data, People or Things.

2. In performing any task, the worker usually deals with all three of these areas.

3. In most tasks, however, the emphasis is on only one orientation--either Data or People or Things. Bernotavicz and Wallington (1970, p. 26) point out that "If three worker orientations are found in one task it is a sign that the task has not been analyzed well enough and that there may be two tasks in what was thought to be one." Preparing a budget is primarily oriented toward Data. Persuading an instructor to use a visual aid is basically People oriented and learning to drive a tractor is focused on Things.

4. Tasks can be further classified as to their complexity. There is a hierarchy of complexity levels for each orientation. Wiley and Wretha (1979) call these levels Functional Skills and list them in order of complexity

in a series of "Worker Function Scales." Definitions of each of the Worker Functions (WF) in the scale is given with examples of each.

5. General Educational Development (GED). This scale tells how much education the worker needs to perform the task. The GED scales are used by the Federal Labor Department (in an attempt) to define needed educational levels more accurately than just "5th grade" or "junior high school." The three GED scales--Reasoning, Mathematics and Language--are based on the curriculum taught at specified grade levels in schools throughout the United States.

6. The GED scale allows separate evaluation of the development level a worker needs to perform the task. By combining the FJA along with the WF, the GED makes it possible to list and code the educational progress needed to perform the task. Fine (1969) lists all GED scales.

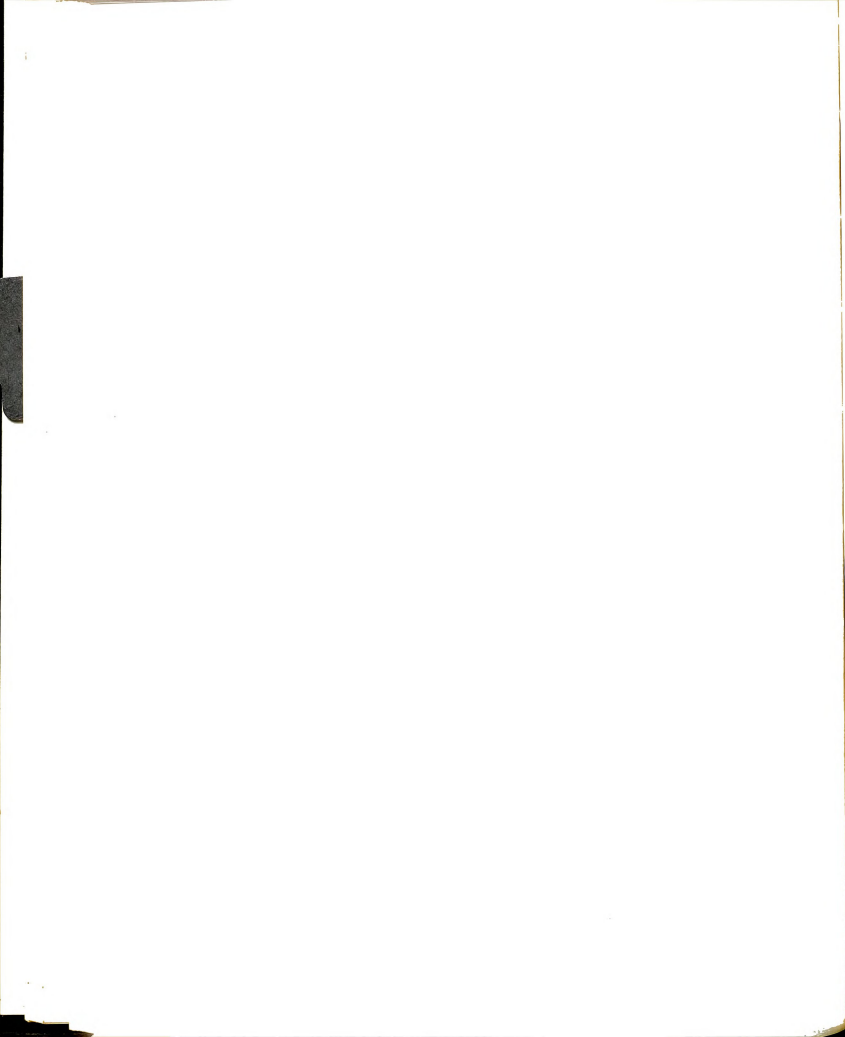
7. A scale of Worker Instructions (WI) allow tasks to be analyzed by the instructions governing the worker. The WI scale has eight levels ranging from the very simple and specific instructions where inputs, tools, equipment, procedures and outputs are all specified to general and complex instructions where practically nothing is specified and the worker must make all the decisions.

8. Every task was measured against the three scales of Worker Functions (Data, People and Things),

General Educational Development (Reasoning, Mathematics and Language) and the Worker Instructions (simple to complex). This permitted distinct classification of tasks from the worker's viewpoint by orientation and by complexity (Figure 2.4). Since the matrix would be too complex if General Education Development (GED) and Worker Instructions (WI) were also shown, the Figure shows only the WF as part of the FJA. GED codings and the WI accompany each task existing to provide additional information about the task's complexity.

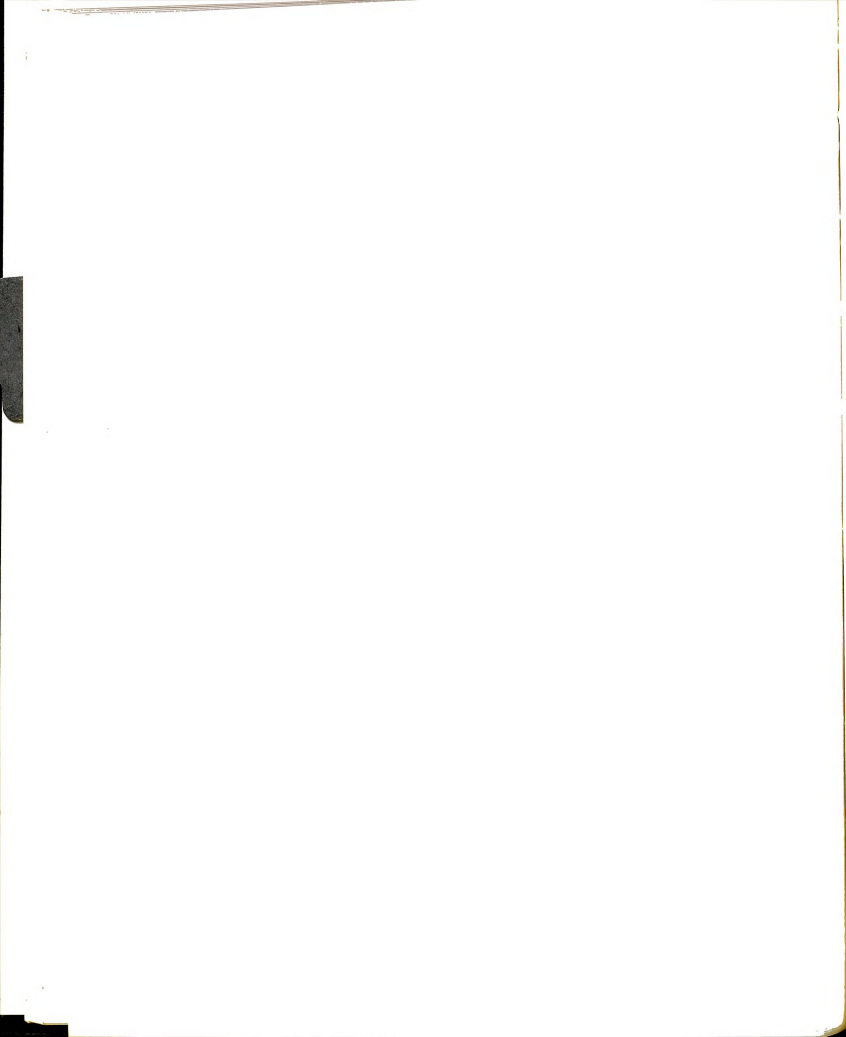
9. "What gets done" classifies tasks according to their products or services. To do this, the JIMS system identified a number of functions basic to the instructional process and called it the Domain of Instructional Technology (DIT). The definitions of media used in DIT were sufficiently broad to let JIMS group the observed tasks by functions to tell "what gets done." Figure 2.4 shows the DIT functions for an instructor. DIT functions, unlike the WF, are not hierarchical by each orientation. A worker could perform different level tasks on Data at the same time, i.e., compiling Design Data level I and Analyzing Design Data at level IV. In JIMS the DIT provided an excellent way to classify tasks which had been analyzed and in 110 job analyses were identified over 1200 tasks.

10. Tasks can be grouped in any number of ways to define a specific job according to the needs and



FUNCTIONAL JOB ANALYSIS (FJA)			WHAT GETS DONE? (DIT)												
			PLANS	PROCURES	PREPARES	DESIGNS	EVALUATES	INSTRUCTS	MANAGES	TESTS	RE-EVALUATES	REVISES	OTHER		
I Sorts II Compiles III etc. IV V	D A T A	1	Lowest Level								Tasks				
		2													
		3	Middle Level								Tasks				
		4													
		5	Highest Level								Tasks				
I Counsels II Teaches III etc. IV V	P E O P L E	1	Low								All Levels of Func- tions				
		2													
		3	Middle												
		4													
		5	High							*	One Level				
I Operates II Services III etc. IV V	T H I N G S	1	Low								One Function				
		2													
		3	Middle												
		4													
		5	High												
															All Functions

Figure 2.4.--Functional Job Analysis of What the Worker Does and What Gets Done (after Bernotavicz and Wallington).

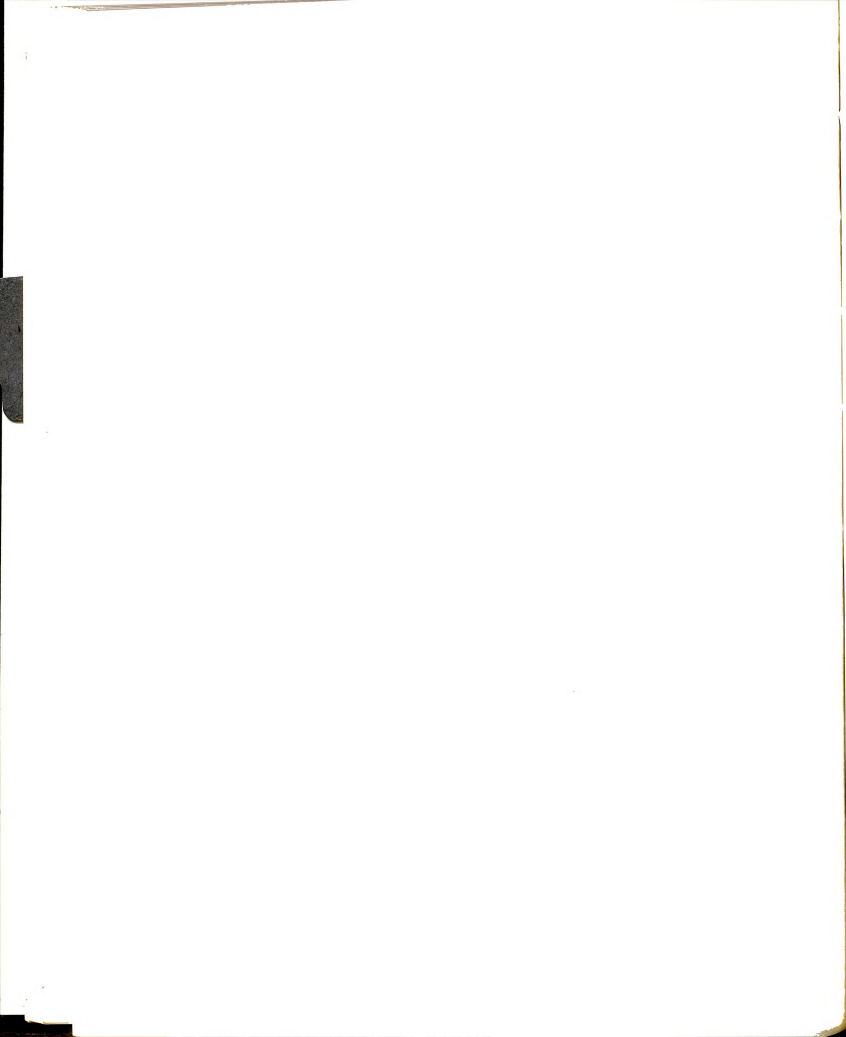


FUNCTIONAL
JOB
ANALYSIS
(FJA)

WHAT GETS DONE?
(DIT)

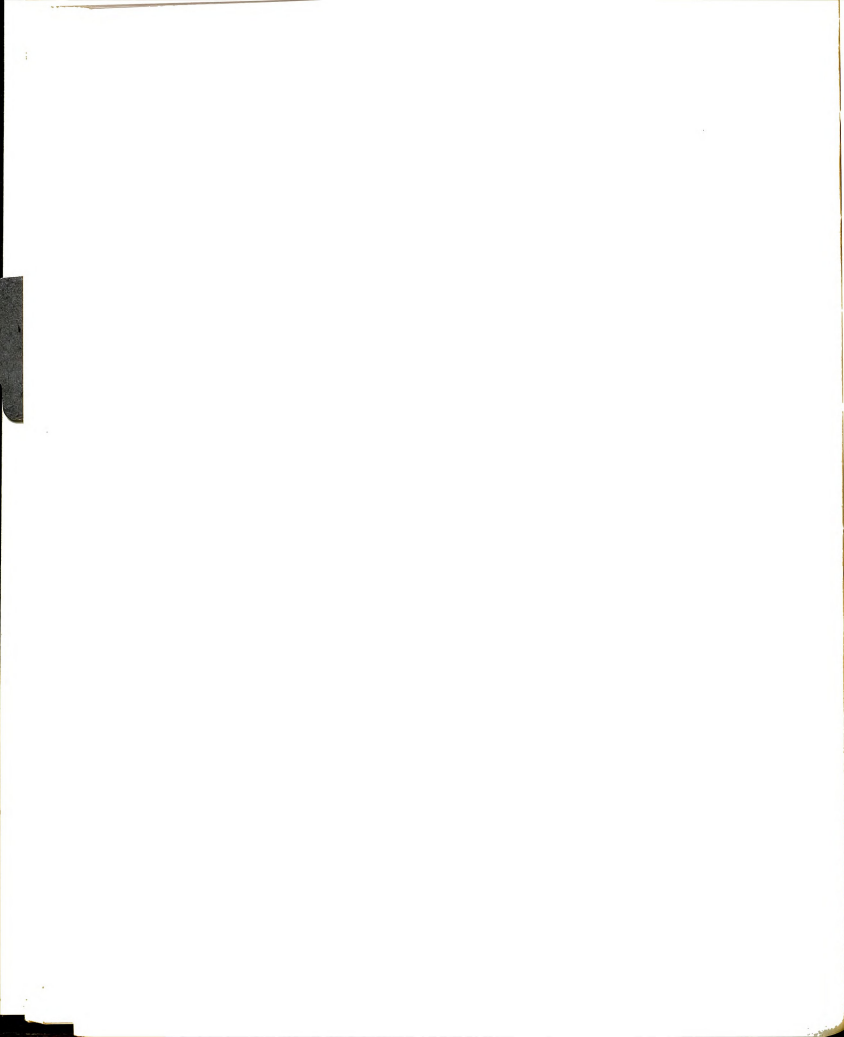
			PLANS	PROCURES	PREPARES	DESIGNS	EVALUATES	INSTRUCTS	MANAGES	TESTS	RE-EVALUATES	REVISES	OTHER
I Sorts II Compiles III etc. IV V	D A T A	1	Lowest Level								Tasks		
		2											
		3	Middle Level								Tasks		
		4											
		5	Highest Level								Tasks		
I Counsels II Teaches III etc. IV V	P E O P L E	1	Low	/	/	/	/	/	/		All Levels of Functions		
		2											
		3	Middle	/	/	/	/	/	/				
		4											
		5	High	/	/	/	/	/	/	One Level			
I Operates II Services III etc. IV V	T H I N G S	1	Low	/	/	/	/	/	/	One Function	All Functions		
		2											
		3	Middle	/	/	/	/	/	/				
		4											
		5	High	/	/	/	/	/	/				

Figure 2.4.--Functional Job Analysis of What the Worker Does and What Gets Done (after Bernotavicz and Wallington).



objectives of the person doing the grouping. How can tasks be regrouped to structure curriculum to train people for those jobs? JIMS found there was no "right way" to regroup tasks to define a job structure. Long accepted terms such as "professional," "technicians," "the hardware people" began to have less meaning. The tasks became the prime concern so "getting your hands dirty" was not something that professionals did or did not do. In fact, using the functional matrix of What the Worker Does and What Gets Done to regroup the separate tasks into jobs, forces an organization to define its goals or determine the rationale behind present job structure.

11. Definitions and levels of training and performance have to be established. How does a trainer prepare people for a specific job? Most colleges use the "saturation approach" in which people are trained in a number of areas with the assumption they will find a job in one of them. Most curriculum teach a little about everything and leave the details to be learned on the job. This works in general with college students because they have learned "how to learn" and "how to adapt" through many years of trial and error in course work. Bernotavicz and Wallington (1970, p. 30) say "this approach is completely inequitable for the training of technicians and aids who graduate from short-term training



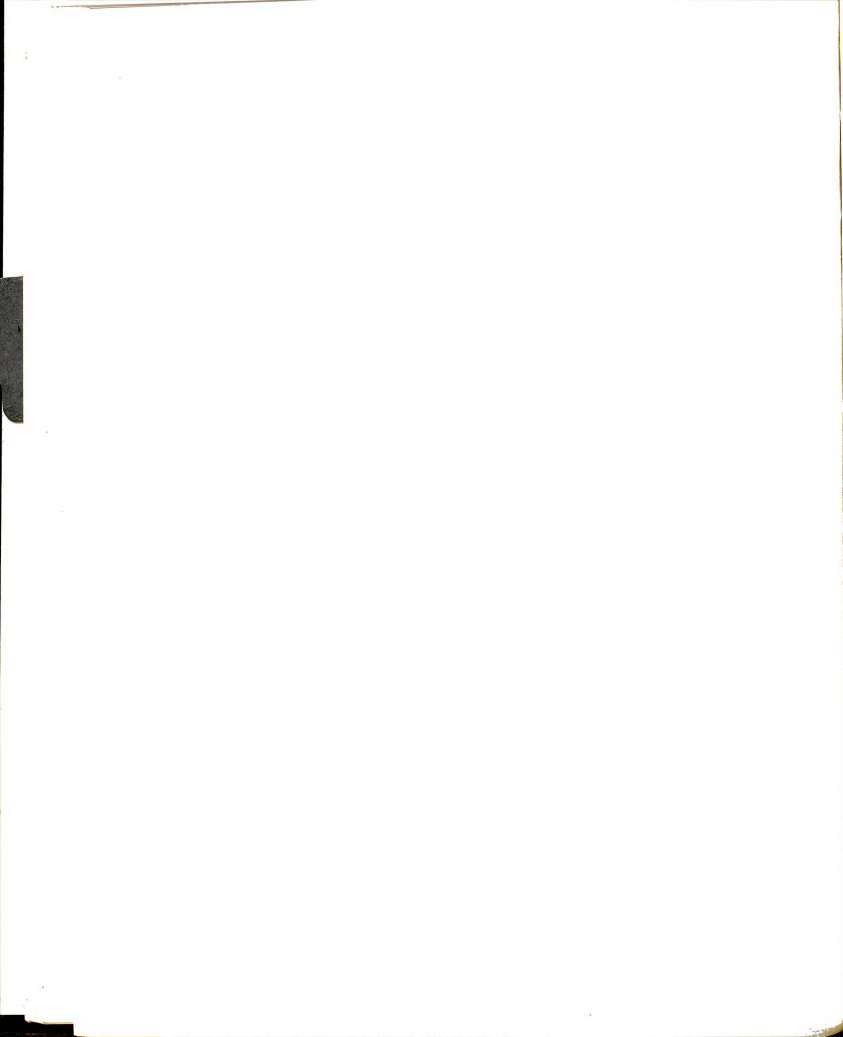
with immediately usable skills." For this type of worker, training must be more precise and focused on limited skills or combination of them. Obviously, jobs with a wide distribution of tasks require long training periods. Education reserves the term "professional" for people with education degrees, no matter what they do or at what level of competence. JIMS found the DIT function does not give any indication of the level of competence.

Distinction Between Aides, Technicians and

Specialists.--Jobs are collections of tasks, often varying in competence levels. The measure of "professional" and "para-professional" is best described in the WI coding which reflects both responsibility and the need for supervision. Using these WI codings three general personnel levels evolved: "the specialist (this includes the term 'generalist'), the technician, and 'the aid.'" The differences between these levels is described by Bernatovicz and Wallington (1970, p. 30).

Aides: have specific instructions about the tasks they perform. The task may be only part of a process, the other parts of which the aide cannot or does not control. . . . Aides can be trained for a task in a relatively short period of time since almost everything they need to know is contained in the task. . . . If something happens which is not covered by instructions, the aide asks for help and cannot be held responsible for solving the problem.

Technicians: have instructions which deal more with a cluster of tasks leading to a specified output. The technician may have a choice of routines to reach a given output. He has a broader view of the situation

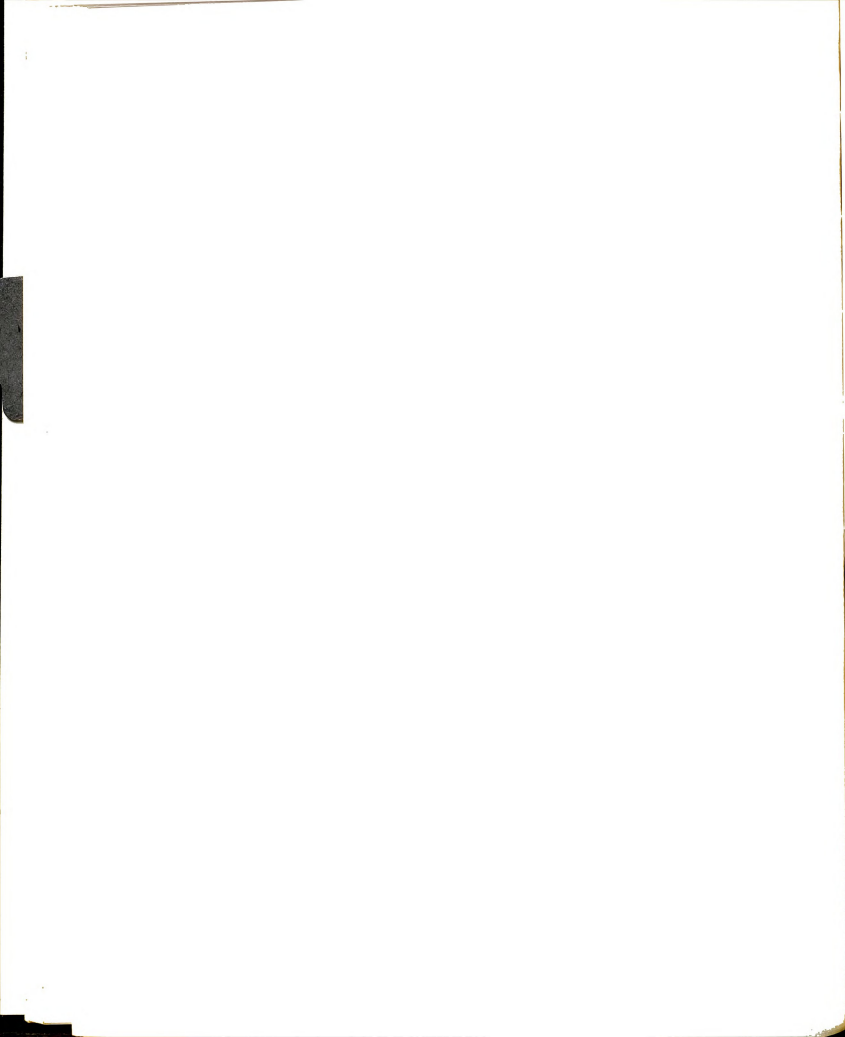


and is expected to generalize more from task to task than the aide . . . (He) is responsible for the product as long as all of the routines necessary to reach the output have been specified and made available to him.

Specialists: don't have as many routines and tasks specified. They become saddled with the general problem and then try to determine what the product should be in the first place and then how best to go about it. Having defined the goals, they are often forced to develop the routines or tasks necessary to implement the goal. They deal with a broad process approach.

If anything varies widely, it is people. The task analyses define only minimal levels of competency and do not include the worker who puts something extra into the job, or finds a better way to do it. People bring their talents and limitations to a task and can alter it significantly.

In summary, JIMS has analyzed hundreds of tasks and placed them in a matrix which can be used in a number of ways to regroup tasks into jobs or to define job requirements. Jobs are collections of tasks which can be analyzed and classified from two distinct viewpoints-- what the worker does (Functional Job Analysis) and what gets done (Domain of Instructional Technology). There are three general levels of tasks and people can perform these only on one job level or on a number of levels falling under the general headings of Specialists, Technicians or Aides. The 1200 tasks defined so far are only a small part of the 2000-plus cell matrix. The JIMS staff is attempting to design a curriculum package to demonstrate how to translate behavioral statements of what people do



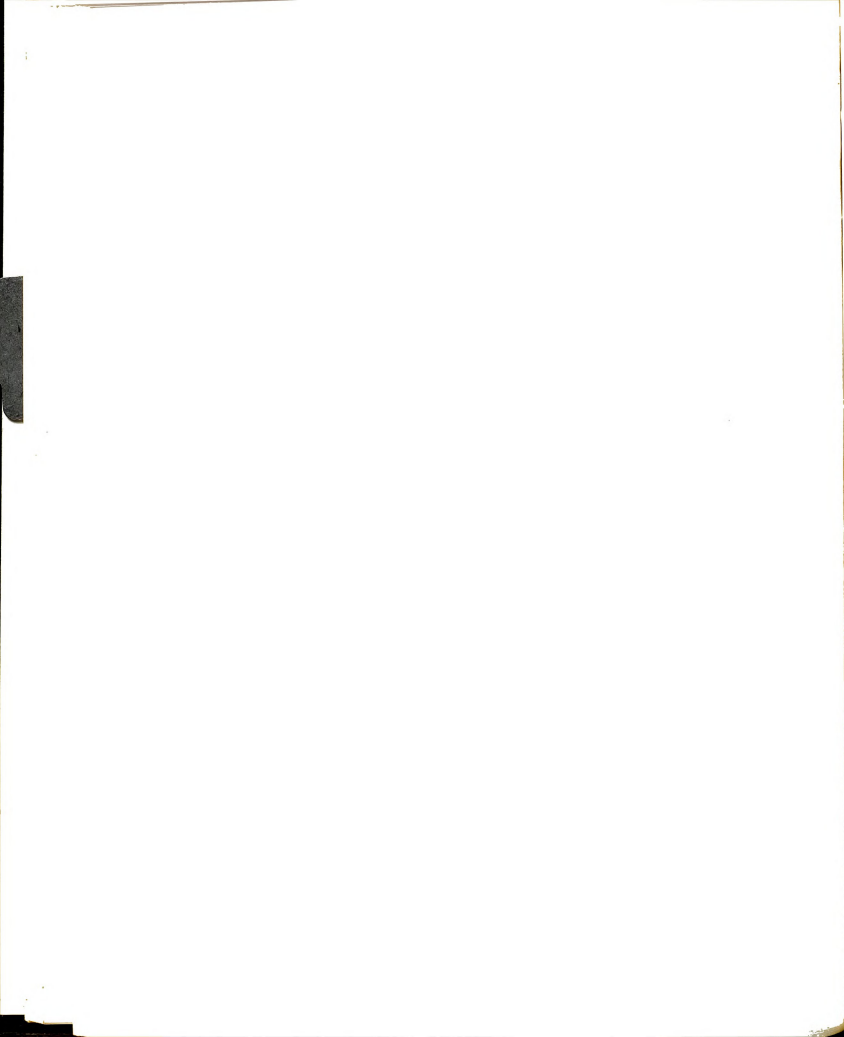
on the job (curriculum). Third, they are developing a job inventory form which could be used by employers to determine what tasks are now performed within their organization so they can assemble tasks into new jobs. Training institutions could use this analysis to determine what tasks employers need performed and to develop a curriculum to teach those tasks.

Curriculum Cost-Effectiveness Evaluation

Techniques for rational revision of educational systems have not been widely discussed. Designers must look for efficient methods to control and monitor curriculum developments as a rational subsystem goal within a complete behaviorally-oriented systems approach to education.

An educational system may be defined as a rational, controlled series of relationships between various elements, interacting to produce stated behavioral changes by motivating students to achieve the system objectives. A true system has clearly defined attainable goals and interacting elements to produce the stated behavioral changes.

Specification of Objections.---Training development and implementation begins with specification of objectives. Then the variables are defined, analyzed, cataloged and controlled to assure achievement of the objectives. System objectives constitute general educational goals such as value judgments of people who decide to establish a



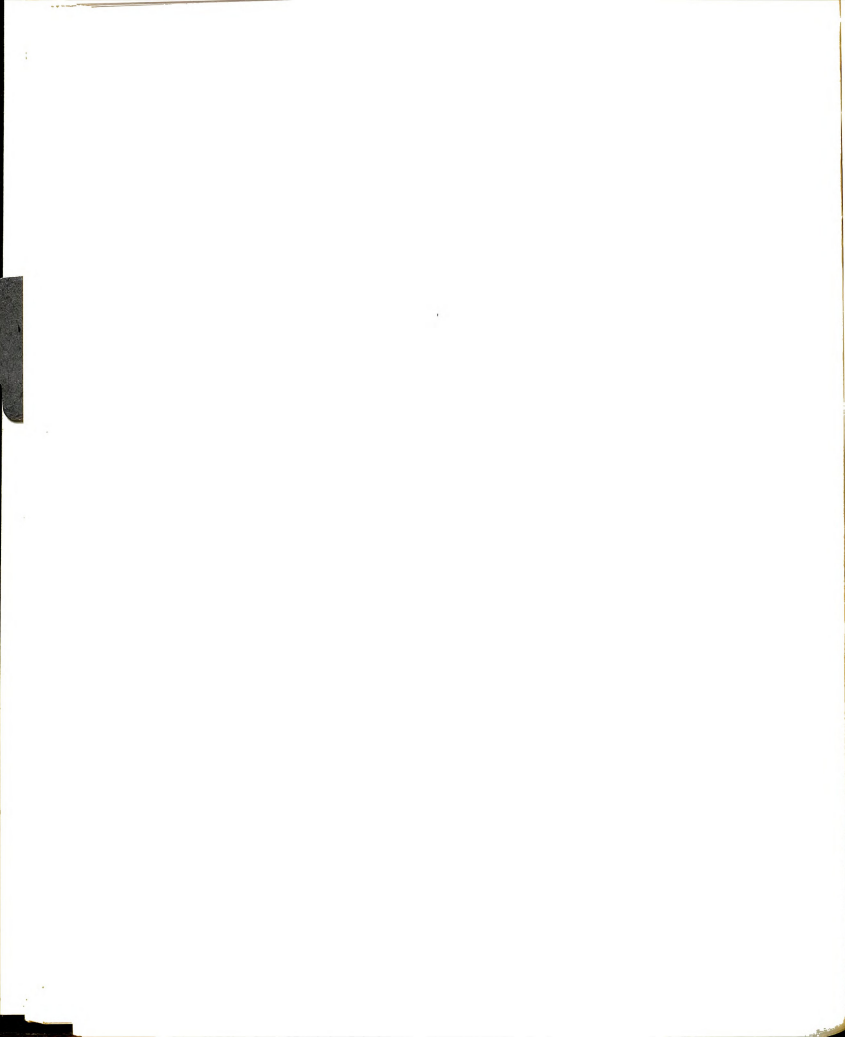
particular education system. Behavioral objectives are precise statements of meaningful units of behavior to satisfy the instructor that a student can perform a task with a desired outcome. System objectives are constants and a system is changed until it can attain them.

Harmon (1970, p. 24) says behavioral objectives should be written and they should include:

1. Conditions: Aspects of performance that represent the 'givens' or environment when the behavior is performed; or special factors that should or should not be allowed to interfere with the student while he is performing the desired behavior.
2. Behaviors: What the student will actually do to show the instructor or others that he has acquired the behavior associated with the objective.
3. Success criteria: How well the required behavior must be performed, how will it be evaluated, and who will evaluate it.

Behavioral objectives are approximations of system objectives. For a system objective where a trainee must learn to drive a tractor, there may be many behavioral objectives, each concerned with a specific aspect of the driving process. Behavioral objectives are empirical. They are chosen, experimented with and changed until their successful attainment by students shows they satisfy the corresponding system objective. This difference is important for cost-effectiveness decisions.

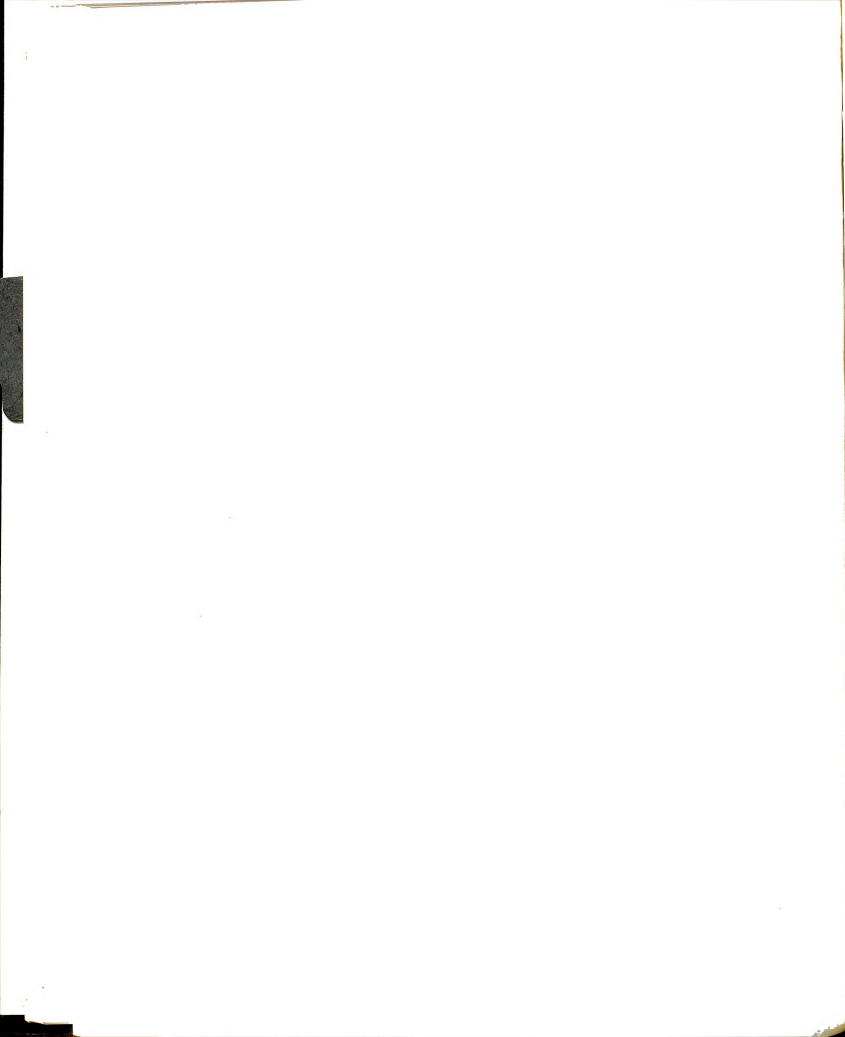
Effectiveness of Existing Systems.--Insufficient money, time and the special characteristics of a particular situation usually result in a less-than-perfect system.



Every educational system represents many compromises but, after its initial implementation the feedback from evaluation can be used to revise and perfect the system more. Harmon (1970, p. 25) describes effectiveness in obtaining system objectives as "the degree of positive correlation between the actual repertoire of a student who has achieved all of the behavioral objectives of a system and the repertoire of an ideal student who exemplifies the perfect attainment of the system objective." If a student or trainee passes the behavioral objectives of a system designed to teach machinery operation but cannot operate a tractor safely, the system has low effectiveness.

Efficiency in attaining system objectives refers to the time, cost and effort involved in the achievement process. It might be effective in teaching objectives but if the price is too high and the process takes too long the system is inefficient. The first aim of any curriculum effort should be to achieve system effectiveness with efficiency as a secondary goal. Harmon (1970, p. 25) points out that "general system effectiveness is usually obtained as the result of a well thought out initial development and implementation effort. Thereafter, modification and refinement of system effectiveness is carried on simultaneously with a refinement of the system's efficiency."

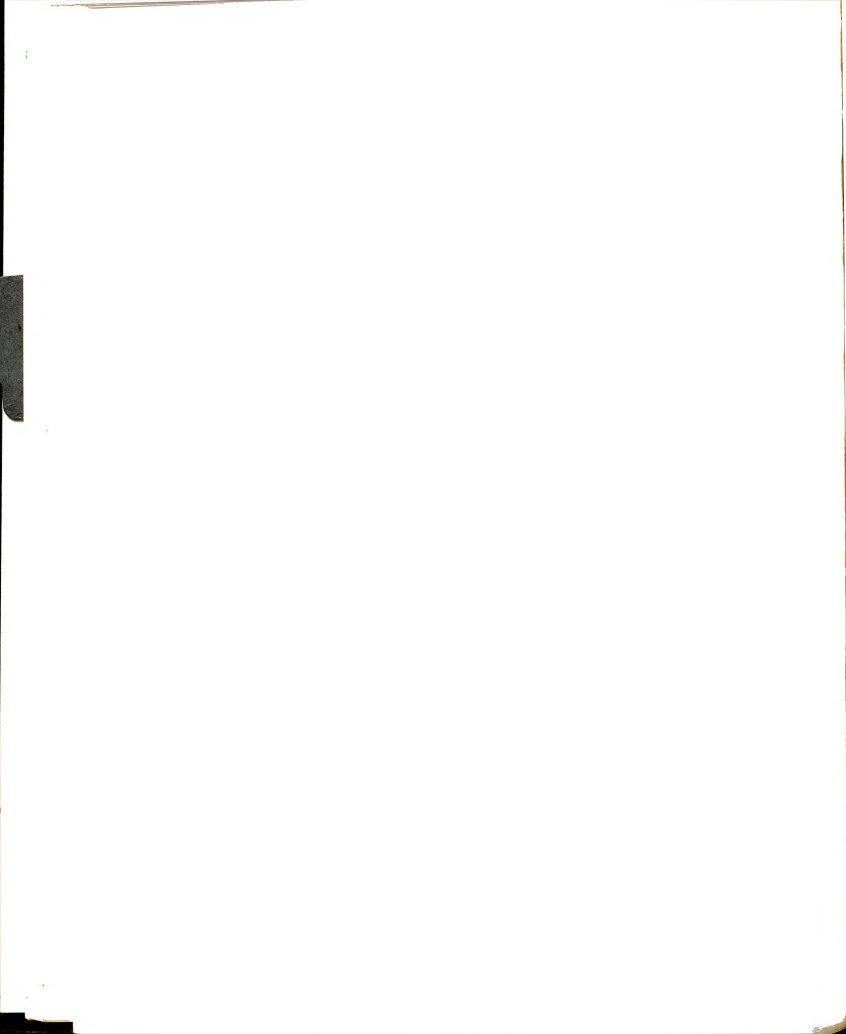
The process of refining system effectiveness is usually done in the initial testing and validation stages.



The techniques of curriculum development take place after the implementation is completed.

Measuring System Effectiveness.--There are two common ways to measure the effectiveness of a training system. Some use conventional testing process to get a percentage score representing the student's or trainee's success in the lesson. A second way is to allow a student to proceed when he passes a unit behavioral objective, by noting the number of behavioral objectives he has achieved. The first method keys the test questions to specific behavioral so the achievement of each can be determined. The second method is not commonly used today because most educational systems are not geared to individualized instruction and must, therefore, keep all students moving at the same pace.

In testing, each question or performance criteria should embody a specific behavioral objective. Passing or achieving that question means passing the specific objective and vice versa. Using criterion tests in programmed instruction is one example. The maximum number of test points should equal the number of behavioral objectives. By evaluating key objectives it is possible to obtain performance without retesting every point in the final evaluation. Cost effectiveness can be maximized by testing smaller units during learning and grouping these into broader comprehensive tests for final analysis.



Harmon (1970, p. 26) suggests measuring effectiveness at milestones "composed of about 20 to 30 behavioral objectives . . . [by] giving the students some sort of test every week or two." . . . In a sophisticated system, results can be recorded on a computer for each interval to simplify the data summation and analysis. The initial step in developing a cost-effectiveness analysis is to generate a list giving an effectiveness score for modules of behavioral objectives. See following example for Unit A:

Unit A		Teaching	\$ Cost	Cost
Instructional Modules		Effectiveness	/Student	Effective-
(behavioral objectives)		(class average)	/Week	ness (Index)
Orientation	(Obj. 1-10)	80%	\$ 25	3.2
Pre-service	(Obj. 11-20)	75%	40	1.9
Control Function	(Obj. 21-20)	90%	42	2.2
Tractor Driving	(Obj. 31-42)	80%	75	1.1

System Costs.--Consider only those costs involved in attaining the system's objectives. The cost of teaching tractor driving is found by totaling all of the element costs together. In analyzing training development, costs must be broken down into the same units for which effectiveness can be determined. For the first 10 objectives of Unit A, for example, specific costs must be available for space occupied, instructional time, administrative services, teaching aids and even trainees' time, if they are reimbursed. Unit costs are established by dividing gross unit costs by the number of students or trainees. If units are not of equal duration or students' progress

at different rates, divide the unit costs by a time factor, to get the cost per student per day or per week.

Cost Effectiveness.--Training cost effectiveness measures what one gets for what one pays. One method is to divide the trainees' average test scores by the total training unit costs, by the number of students, by the number of weeks. Comparison of derived indexes permits a relative ranking of cost-effectiveness by units of instruction. An index of 3.2 is better than 1.1 above but is not necessarily three times more effective. By converting the dollar cost figures into percentages of total dollars spent, it would be possible to make this latter deduction.

An instructional unit is highly cost effective when the costs are low and the results are excellent. The closer the index is to 100, the higher the unit cost-effectiveness; and the closer to 0 the lower it is.

<u>Cost-Effectiveness</u>	<u>Cost-Effectiveness Index</u>	<u>Effectiveness</u>	<u>Cost</u>
High	Close to 100	Very high	low
Low	Close to 0	Very low	high

If some units cost more than others, costs can be cut by leaving out unnecessary material which might be using valuable training time. On the other hand, a learning experience might not be adequately tested. In this case, additional behavioral objectives can be tested and treated as a separate unit to determine cost-effectiveness.

Key behavioral objectives in each unit must be identified and weighed against the course objectives. Resources can be shifted from units with high cost effectiveness to units measuring low in cost benefits, to maintain a high standard average. For example, a unit scoring high with an index of 100 could have teaching time taken away from it, to perhaps reduce its effectiveness to 80%; and at the same time the saved time could be spent on a unit scoring only 50 to raise its effectiveness to 80% to improve the overall system effectiveness. As Harmon (1970, p. 77) points out, however:

the cost-effectiveness index by itself, however, can never be used as the sole basis for making decisions, since the primary concern of curriculum development is not cost-effectiveness but, the achievement of system objectives. Thus, the final decisions are always human, since it is a human function to decide how closely the systems behavioral objectives approximate the system objectives. . . . Perhaps its greatest service is in forcing us to analyze courses of instruction in specific units with respect to the achievement or non-achievement of behavioral objectives.

Controlling the Quality of Training

A school or course that has a quality control system has the means for evaluating and improving the effectiveness of its training. The purpose of quality control is (1) to ensure that only those students who meet the training objectives satisfactorily graduate from the course, and (2) to provide a means for continuously monitoring the training program and improving it when it is

found deficient (Smith, 1965, pp. v, vii). The Human Resources Research Office studied the technology for developing training and prepared the following general guidelines for controlling the quality of curriculum engineering in military training:

A test--a standardized situation that requires the student to demonstrate that he has mastered one or more objectives of the course--is the most effective of the various means for evaluating a training program.

Tests to monitor the effectiveness of training should (1) directly reflect the course objectives, (b) measure the student's ability to perform the task, rather than his mastery of knowledge and skill components, and (c) be scored on a pass-fail basis for each item.

Tests to diagnose instructional difficulties should (1) directly reflect course objectives, (b) measure the student's attainment of the knowledge and skill components of the task rather than his ability to perform it, and (c) be scored on a pass-fail basis.

An absolute, rather than a relative, scoring system is needed in order to establish a definite standard of student performance.

Two characteristics determine the validity of tests used in quality control of training--the extent to which the test items are direct reflections of the course objectives, and the adequacy with which the test items sample the objectives.

. . . factors that may contribute to test reliability include the conditions under which the test is administered, the instructions given, the student himself, the scoring procedures, and the length of the test.

The major problem in developing the test item is to communicate the question or problem clearly to the student. . . . (a) The language used should be as simple as possible. . . . (b) Care should be taken to see that the test does not provide the student with hints as to the correct answer. (c) Clear guidance should be given to examiners . . . (d) A check should be made to ensure that the conditions stated in the objective are reflected in the item, as tested.

Strong support from all supervisory levels is necessary to make the quality control system work effectively. Everyone must have a clear idea of the purpose and rationales of the system. Wide-spread and continuing orientation of key personnel is a requirement.

Establishment of a separate unit to perform the key functions of the quality control system is a critical element. The unit should not be a part of, or under the direction of, a particular course supervisor. . . .

Success of a quality control system depends upon interaction of the various elements. The system will be effective only if tests are properly administered and scored, if the reports of testing are understood by the instructional units, if appropriate corrective action is taken and its success measured.

Research in Farm Machinery Training Courses

A study made by Bittner (1962) reported some correlations existing between selected aptitude test scores and the grade point averages of students enrolled in the Farm Equipment Service and Sales technical program at Michigan State University from 1956 to 1959. These correlations were used to interpret the significance of aptitude tests in predicting student achievement in course work.

The specific objective was to determine the degrees of relationship that existed between aptitude test scores of 42 students who graduated and their grade point averages in two groups of courses. The first group consisted of non-engineering subjects such as agricultural economics, soils science, business law and psychology in which the students typically had trouble getting good

grades. The second consisted of practical agricultural engineering subjects such as service shop, farm machinery, tractors and power units, drainage and irrigation, rural electrification and farm structures in which students generally had the least difficulty.

The Pearson product-moment coefficient of correlation was used to determine the degree of relationship between each ability test score and each grade point average.

The following aptitude ability test raw scores were utilized in the study:

- A. The Otis Quick-Scoring Mental Ability Test, Form Gamma
- B. The Cooperative Reading Test, including; (1) Vocabulary, (2) Rate of Comprehension, and (3) Level of Comprehension
- C. The Differential Aptitude Test, including:
(1) Numerical Ability, (2) Space Relations, and (3) Mechanical Reasoning

The coefficient of correlation indicated whether students who obtained high scores on the ability tests also obtained high grade point averages. A correlation of +1 signified the student had the highest ability test score and the highest grade point average. A correlation of -1 showed exactly the reverse order, and a 0 correlation indicated there was no relationship between the two variables.

The correlation coefficients obtained by Bittner (1962) are shown in the following chart:

<u>Aptitude Tests</u>	<u>Correlation with Course Grades</u>	
	<u>Engineering Subjects</u>	<u>Non-Engineering Courses</u>
Rate of Comprehension	+ .49	+ .70
Level of Comprehension	+ .42	+ .58
Vocabulary	+ .38	+ .54
Mechanical Ability	+ .44	+ .36
Spatial Relations	+ .13	+ .17
Numerical Ability	+ .26	+ .17
Otis, I.Q.	+ .49	+ .31

The highest correlations were between the reading test scores and the non-engineering course grade point averages, ranging from .54 to .70. The lowest correlations also were found between these courses and the differential aptitude test scores. In the technical engineering subjects the best predictors of success were the reading Rate of Comprehension and the Otis I.Q. tests followed closely by the Mechanical Ability aptitude test. Spatial Relations and Numerical Ability tests are apparently of little value in predicting student achievement in practical or technical courses.

The correlation coefficients can be used to indicate the probability that a student with a given aptitude test score will achieve a certain grade. Expectancy tables from Thorndike and Hagen(1955) were used

for correlation coefficients $r = .00$, $r = .40$, $r = .50$, $r = .60$, $r = .70$, and $r = .80$ (See Chart below). The correlation coefficient for the Otis, I.Q. and the Rate of comprehension of engineering subjects, for example, was .49. The achievement of a student, whose aptitude test scores fall in the lowest quarter, can be predicted by looking at the expectancy table for $r = .50$. Of the students in this group, 48% can expect to receive grades falling in the lowest 25% of the grade point averages; and 7.3% can expect to receive grades in the top 25% of the class. In contrast, students or trainees whose aptitude test scores are among the top 25% can expect to do much better, with 48% getting grades in the top quarter of the class and only 7.3% getting the lowest grades. The trainee will probably be more impressed with the possibility that he will do well than with the chance that he might not do good work.

Prediction Accuracy for Correlation Coefficient Value of $r = .50^*$
(Per cent of cases in each column and row)

<u>Quarter on Predictor</u>	<u>Quarter on Criterion</u>			
	<u>4th</u>	<u>3rd</u>	<u>2nd</u>	<u>1st</u>
1st	7.3	16.8	27.9	48.0
2nd	16.8	26.8	29.5	27.9
3rd	27.9	29.5	26.8	16.8
4th	48.0	27.9	16.8	7.3

* Source: Thorndike, R. L. and E. Hagen, Measurement and Evaluation in Psychology and Education (New York: John Wiley and Sons, Ltd., 1955).

CHAPTER III

THE DESIGN OF A SPECIFIC COURSE FOR TRAINING BASIC TRACTOR OPERATORS

Sample Training Course and Pretest Group

The basic course consists of 65 lessons, complete with measurable behavioral objectives, information for trainees, practical trainee exercises, suggested visual aids and evaluation techniques. With a detailed schedule and an Instructors' Training Program, the course forms the backbone of an Instructors' Manual. The needs and the current results of this training program for the Basic Tractor Operator (BTO) as pretested, and its design and evaluation form the foundation for this thesis. Selected excerpts illustrate the concepts and possibilities of this technique for individualizing instruction and training manpower.

Course Sample

To show how the BTO course was conceived and the skills and knowledge developed using systems analysis and operations research techniques, Lesson B-9 on Servicing the Dry-Filter Air Cleaner is discussed and illustrated in detail in this chapter. Positive attitude development was

emphasized in the first lesson of each series (A, B, C, etc.) and Lesson D-1 on General Safety in Controlling the Tractor is used as an example of attitude reinforcement. The complete list of lessons is given in Appendix A in the Sequential Lesson Outline for the BTOC, Grade I.

Population Sample

A small Grand Rapids area subgroup (23) of a much larger population of migrant workers (10,000) seeking work annually in Michigan was used in this sample study. This particular cluster group was unique because it elected to remain in the northern area during the winter of 1969-70 rather than return south, after the regular harvest season.

Assisted by the United Opportunity for Migrants, Inc. (UOMI), some individuals found part-time jobs and all attended an adult education class. Seventeen workers in the class expressed an interest in becoming qualified tractor operators. They were given an opportunity to attend a special training course on tractor operation and maintenance. The UOMI coordinator selected trainees on the basis of interest and willingness to be trained. No individual was excluded because he lacked previous education, experience, or aptitude. Of the 17 trainees who attended at least 10 became qualified as Basic Tractor Operators, Grade I.

The testing program required that the sample group be a geographical cluster of migrant workers able to work

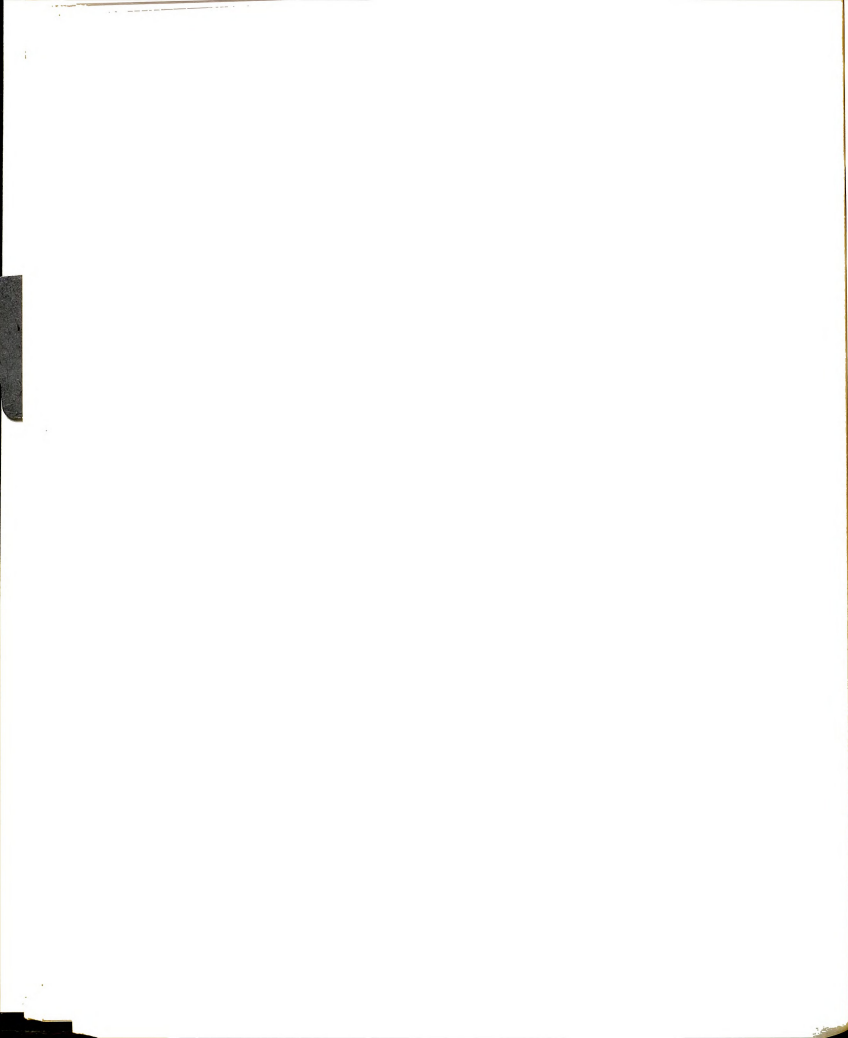
half-time (20 hours) and train half-time (20 hours) each week. A training record was kept on each trainee who attended the course. Several of the 23 workers could not attend because of lack of transportation or housing facilities at the training site.

The characteristics of the trainees in this cluster are given in Chapter V. It is believed that this group is similar to the general population of migrant workers seeking year-around employment. Clusters in other geographical areas could be used for subsequent samples in follow-up and validation testing because the cluster and not the individual is selected. Each member of the population is uniquely assigned to a cluster.

Selection of a cluster is also a judgment sampling. The cluster of migrants evaluated, trained, and tested were judged by UOMI to be representative of the total population on the basis of available information. However, variability and bias of the estimates made cannot be measured or controlled. Strong assumptions were made about this unique cluster and their receptivity to and suitability for training.

Measures for Collecting and Analyzing Data

Trainees were selected by an agency outside the control of the training team. Training was requested for winter 1970 by UOMI in cooperation with the Grand Rapids

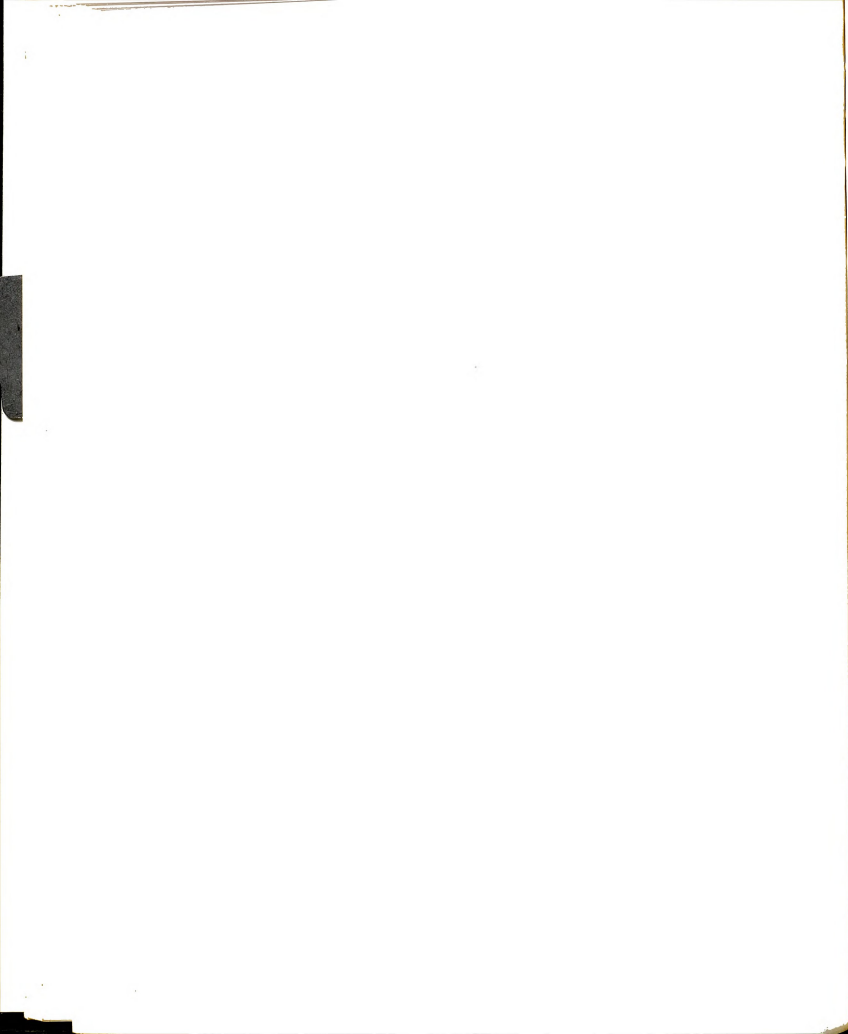


(Michigan) Junior College (GRJC). At that time, the training program, lesson plans, and visual aids were under development by a team in the Agricultural Engineering Department at Michigan State University.

The MSU team trained the instruction staff of one master teacher and four assistant instructors--two retired farmers and two MSU agricultural engineering students. Course designers developed all instruments for enrolling the trainees, testing, and evaluating the program except for the aptitude tests. The Michigan Employment Security Commission was asked to give its standard General Aptitude Test Battery (GATB) to the trainees at one of the adult education classes before training began. This testing, however, was delayed until after training started so identification of aptitudes and worker traits was not made for the migrant cluster.

The forms and instruments developed for the preliminary testing program will be discussed in detail in Chapter IV. They include:

1. The Trainee Enrollment Form EV-0.
2. Pretest and Post-test Forms for all 65 lessons EV-1.
3. A Trainee Daily Training Evaluation Form EV-2.



4. An Instructor Daily Lesson Evaluation Form EV-3.
5. A Trainee Permanent Record Form EV-4.
6. Final Evaluation Events 1-7.

Complete but limited data were collected in this initial field test of the Basic Tractor Operators' Course and training program. Since the first test group was small, plans were made to expand the testing to one and possibly two foreign countries in August and September 1970 under controlled conditions, using lessons learned as a result of the first test. Requests for financial support to permit this testing were turned down by the research cooperator, Deere and Company. The farm machinery industry experienced severe losses in 1970 and support for testing overseas was withdrawn. The preliminary testing program with Puerto Rican and Mexican descent migrant workers was very encouraging. It is hoped other evaluation tests can be conducted in the near future.

The data were to be put on punch cards and computerized for standard statistical analysis using the chi-square, t-tests, analysis of variance and/or similar techniques. But with the small sample of trainees such analysis would be inconclusive based on numerical techniques. The

training program, course content, and trainee evaluation were therefore studied objectively based on the performance of the trainees and the degree of response to training. This pretest is the beginning of an extensive testing and evaluation program which can be analyzed quantitatively by computer science techniques when sufficient data are available.

Design of Instructional Systems Using a
Modified Structured Learning and
Training Environment (MSLATE)

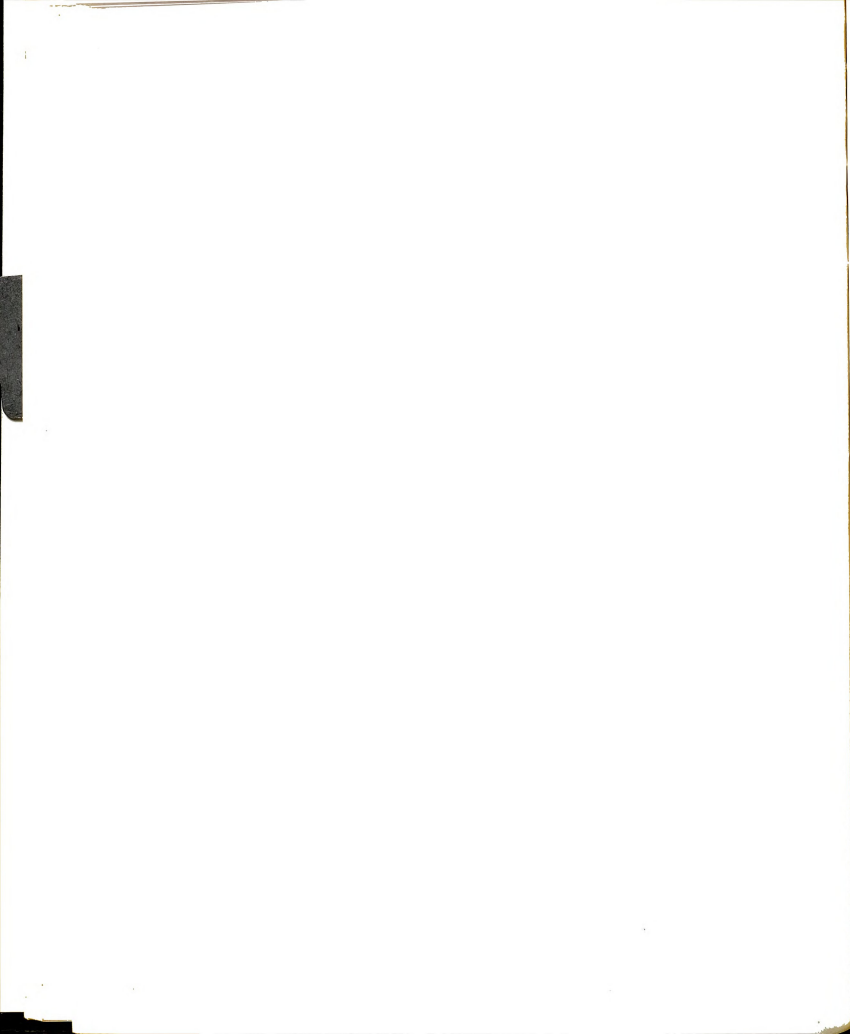
The Structured Learning and Training Environment (SLATE) Theory of Learning

The SLATE system of instructional design includes the following basic steps according to educational psychologists:¹

Carefully analyze training system and develop a
system-operating description.

1. What are the characteristics of the trainees?
2. How are the trainees chosen and what controls their selection?
3. Look at the machine the trainee is being trained to operate.
4. What assumptions can be made about the training environment?

¹R. H. Davis, Associate Director, Educational Development Program and Instructional Development Service, Michigan State University, personal interview, September, 1969.



5. List the task jobs by priority for each class operator.
6. Show how each task is performed step by step with a flow diagram.
7. In the task analysis make a detailed description and describe the conditions under which the task will be carried out.

Define the objectives of training.

1. State very specific behavioral objectives written in measurable terms.
2. Show how each objective is interrelated with the task description and analysis.
3. Base the course and lesson content on the desired changes in individual behavior.

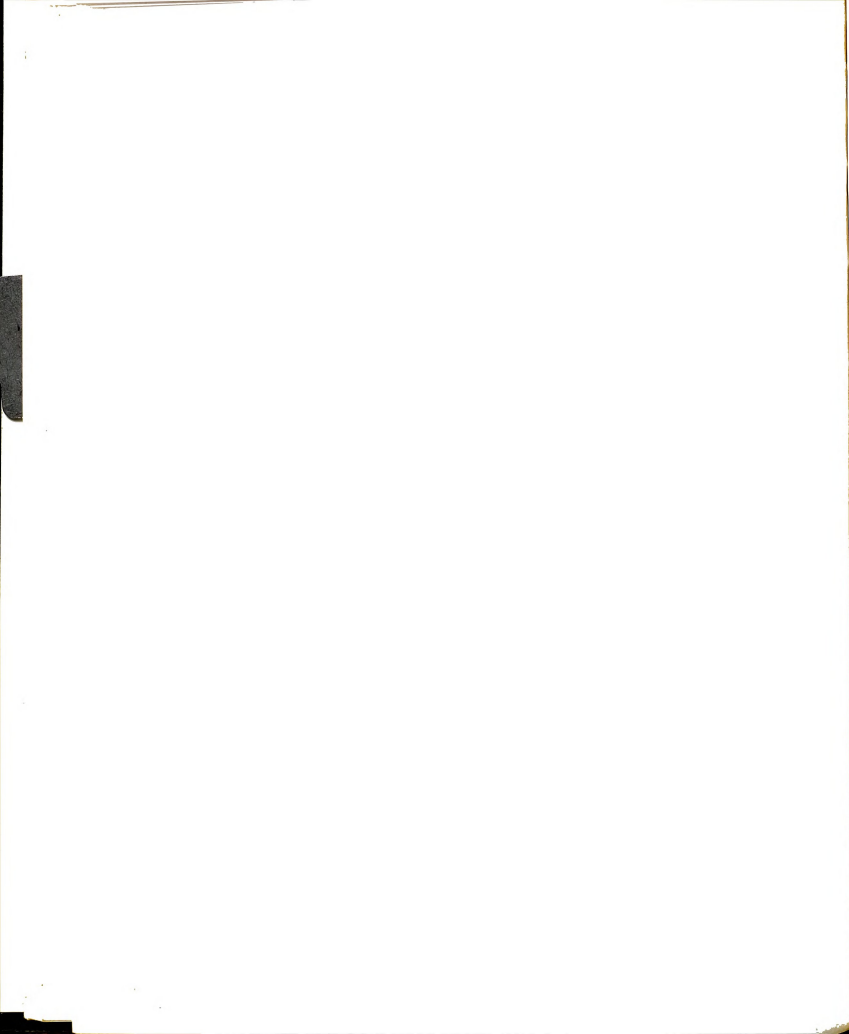
Determine how to best achieve the training

objectives.

1. Determine the kinds of learning involved.
2. Use methods best suited for appreciation, awareness, student participation, and interest maintenance.
3. Develop the necessary training aids and the lesson plans.

Evaluate the training system.

1. Measure how students perform in real life situations.
2. Use the evaluation to bring about changes in the training program.

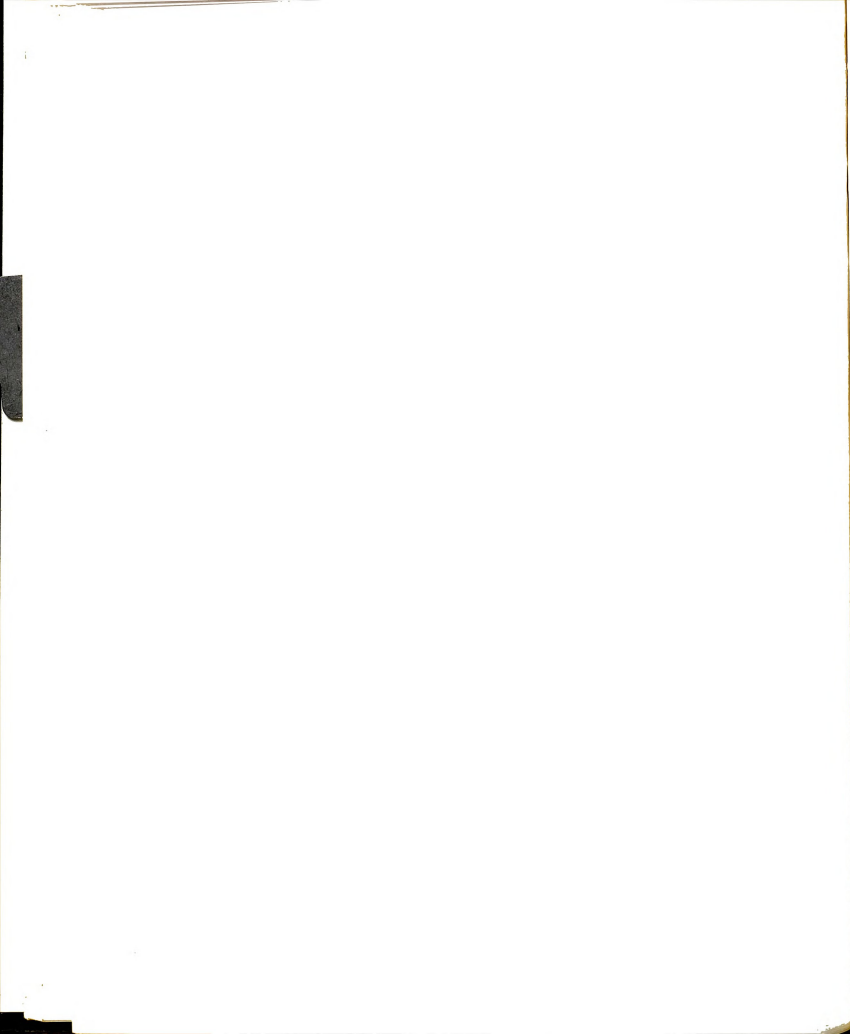


3. Consider training as cyclical.
4. Develop follow-up programs and refresher training for previous graduates.

General System Objectives of Agricultural Mechanization Training

Using the concept of a Modified Structured Learning and Training Environment (MSLATE), system objectives were developed to provide a procedure for developing training programs in agricultural mechanization.

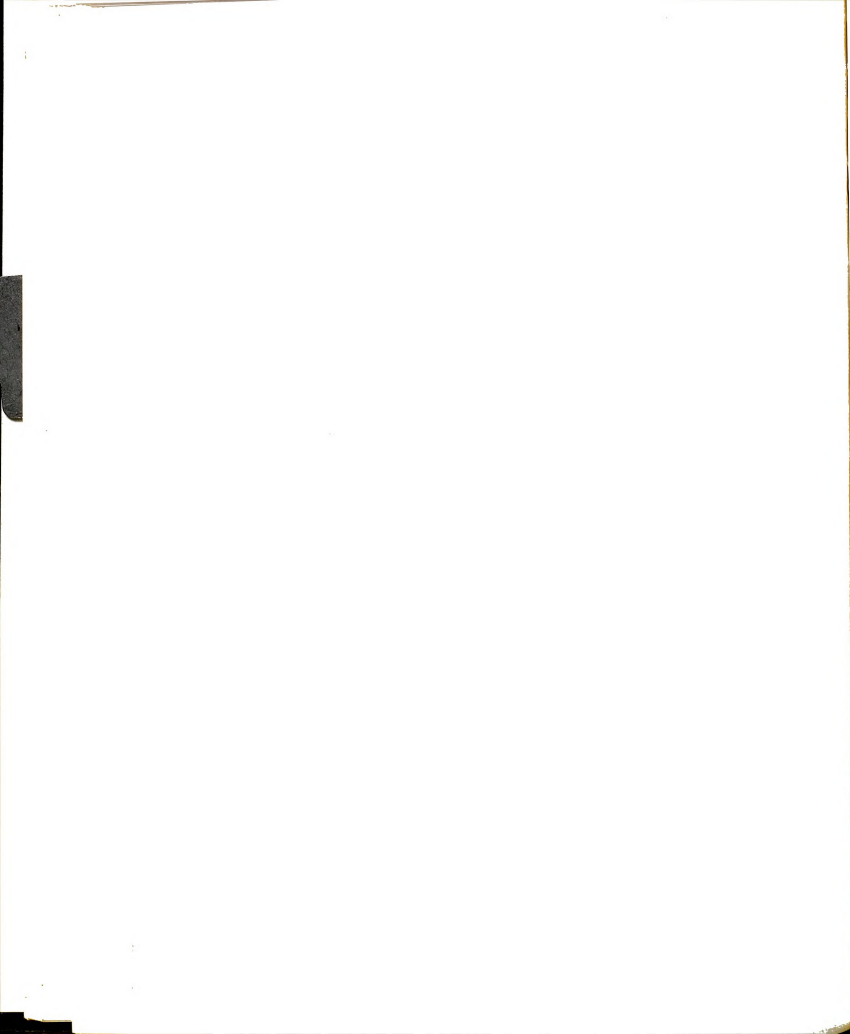
1. Survey the local, regional, and national needs to determine trade and industry requirements for vocational and occupational skill training.
2. Define the skills individuals need to qualify for specific occupations or occupational clusters.
3. Select the skills which can be provided in a specific training program of finite length and cost.
4. Determine who is eligible for training and who would benefit from such training.
5. Appraise each applicant's potential abilities and the suitability of his background and attitudes for training.
6. Determine the entry behavioral characteristics of potential or selected trainees.



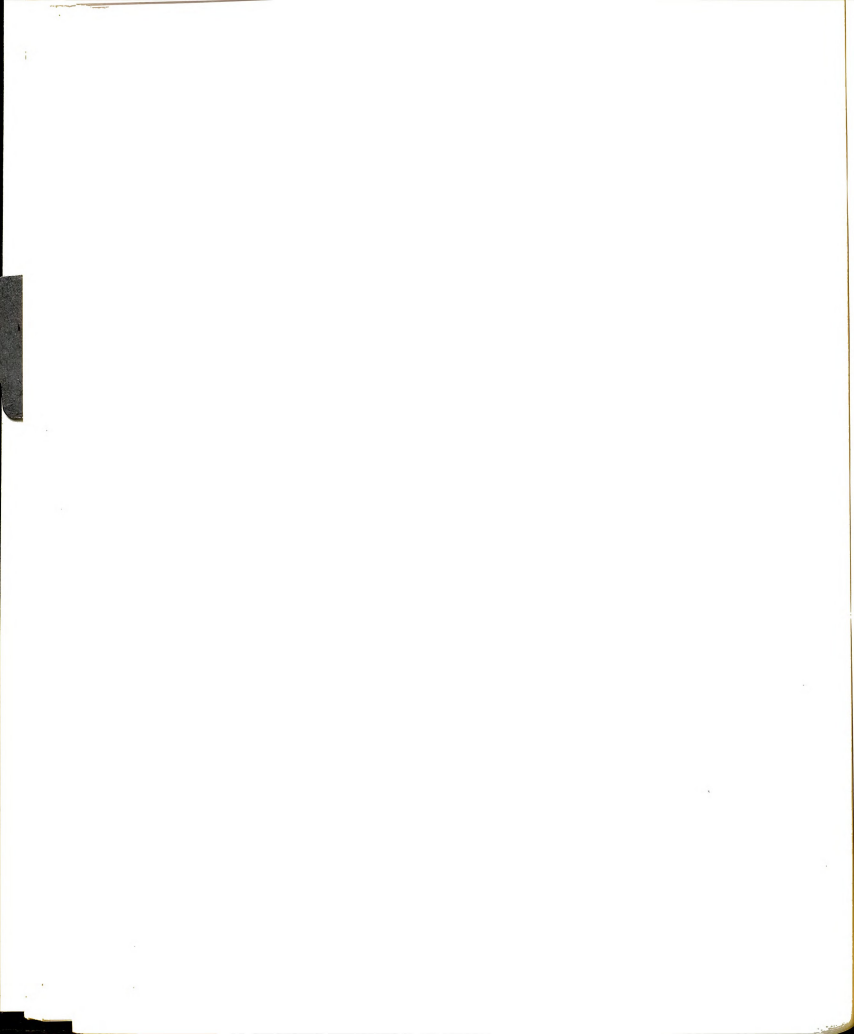
7. Design a training program to provide the essential information and skill training to meet behavioral objectives for a specific machinery operators' course.
8. Write the training program to include the behavioral objectives and activities needed to provide suitable experiences, develop skills, and induce positive attitudes in the learner.
9. Develop an evaluation procedure and instruments to measure the effectiveness of the training program from the instructors' viewpoint.
10. Develop an evaluation procedure and instruments to measure the trainee's achievements in satisfying the behavioral objectives.
11. Conduct a preliminary test of the training program with disadvantaged and/or foreign-language trainees.
12. Use feedback to reappraise the effectiveness of the course format, lesson content, and implementation and revise as required to improve the quality of training.

Specific Objectives of a Farm Tractor Operators' Training Program

To qualify as a basic farm tractor operator the following objectives were established for the trainee:



1. Use and describe the function of all tractor instruments and controls.
2. Start and properly warm-up the tractor engine.
3. Perform all daily and weekly maintenance services according to the manner prescribed in the owners manual.
4. Keep simple maintenance service records.
5. Skillfully maneuver the tractor.
6. Use the tractor with selected implements and associated equipment in productive agricultural operations.
7. Adjust and maintain selected implements during field operation.
8. Use the tractor and equipment safely as described in owners manual and training course.
9. Operate the tractor and equipment on public roads according to the rules established in his country.
10. Understand the basic operation of the tractor and its engine as described in this training course.
11. Recognize the need for and contact the supervisor or mechanic when the tractor needs care beyond his capabilities.
12. Make common sense judgments concerning the wise use of the tractor and use it only in an efficient manner.



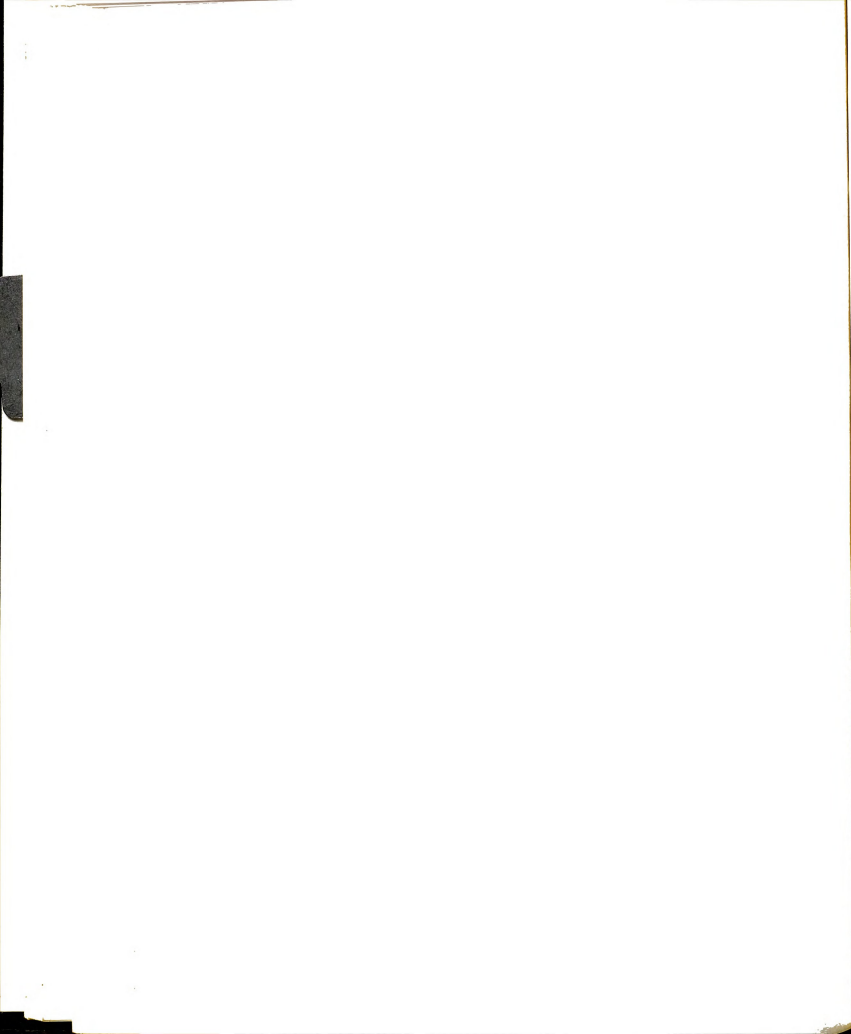
A Systems Conceptual Theory of Trainee Learning Using MSLATE

All learning takes place in a complex environment modified by all the past experiences of the individual. Each input in the new training environment interacts with other new inputs and past influences, to bring about changes within the individual. How rapidly and permanently this change is etched on the trainee depends on the instructor's skill, the quality of the training course, and the amount of distraction of other non-training factors. The entire process must be continually evaluated to minimize the negative influences and accent the positive learning experiences.

Trainee Interaction in an Environment.--The goal of all teaching is effective learning. The good teacher plays a critical role in modifying the training environment. He does this by individualizing instruction to meet the needs of the trainee(s).

Active learner participation is far superior to passive content memorization. Meaningful materials and tasks are learned more readily than nonsense information. However, there is no substitute for repetitive practice in overt skill learning or in the memorization of unrelated facts that must be automatized.

Information concerning good performance, knowledge of his own mistakes and feedback on successful results will also assist the learner. The transfer of knowledge



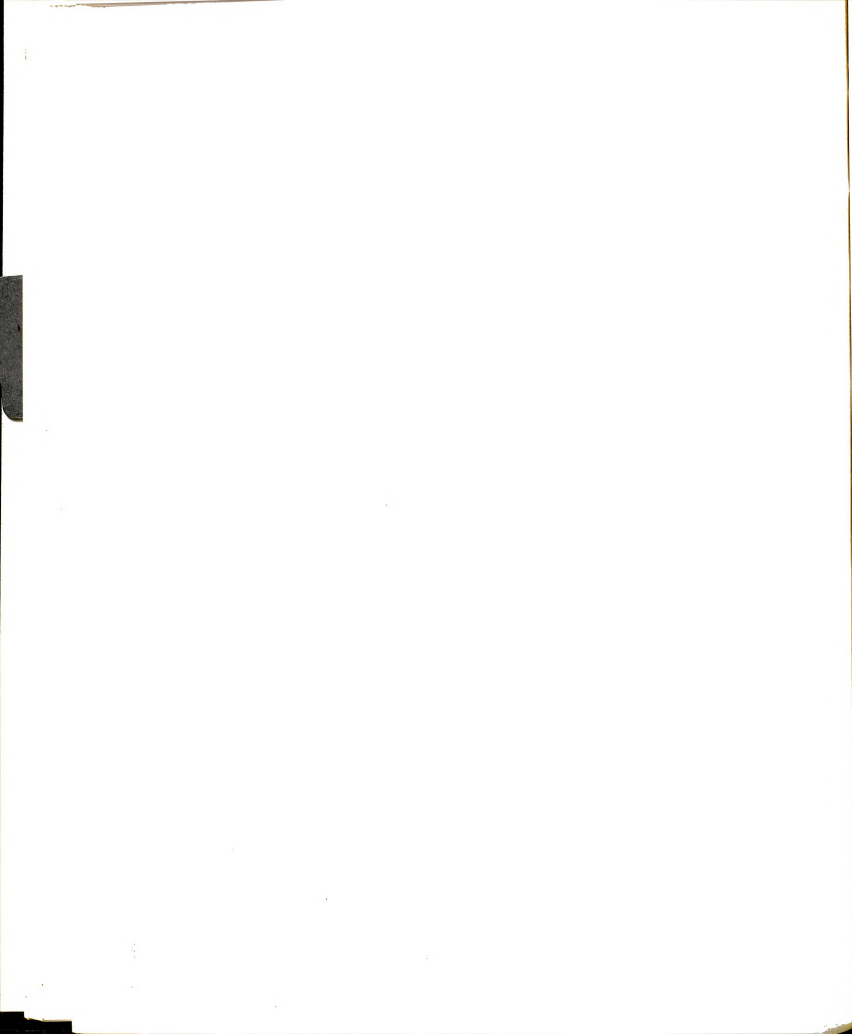
to new tasks will occur more smoothly if the learner can discover relationships for himself and if he has had experience in applying these principles to a variety of tasks.

Thinking is too often left to chance. Learners think when they encounter obstacles or challenges to action that interest them. By thinking they design and test plausible ways of overcoming blocks or obstructions. Concepts must be presented in various and specific situations to develop familiarity and breadth. Pupils learn new subject matter that conforms with previous attitudes better than new material that opposes their previous attitudes or views (Dole, 1970, p. 42).

Input-Output-Feedback Relationships in the Learning Environment.--A learning system consists of three basic parts:

1. Knowledge, including skills and attitudes, worthy of human transfer.
2. People, including students, trainees or citizens, desiring or needing (1).
3. An instructional system, including teachers, techniques and aids used to facilitate the learning of (1) by (2).

The structured relationship of input, output, and feedback illustrates the three major adjustments that must be satisfied for the training system to maintain compatibility with its environments (Figure 3.1). The environment



MSLATE

Modified Structured Learning and Training Environment

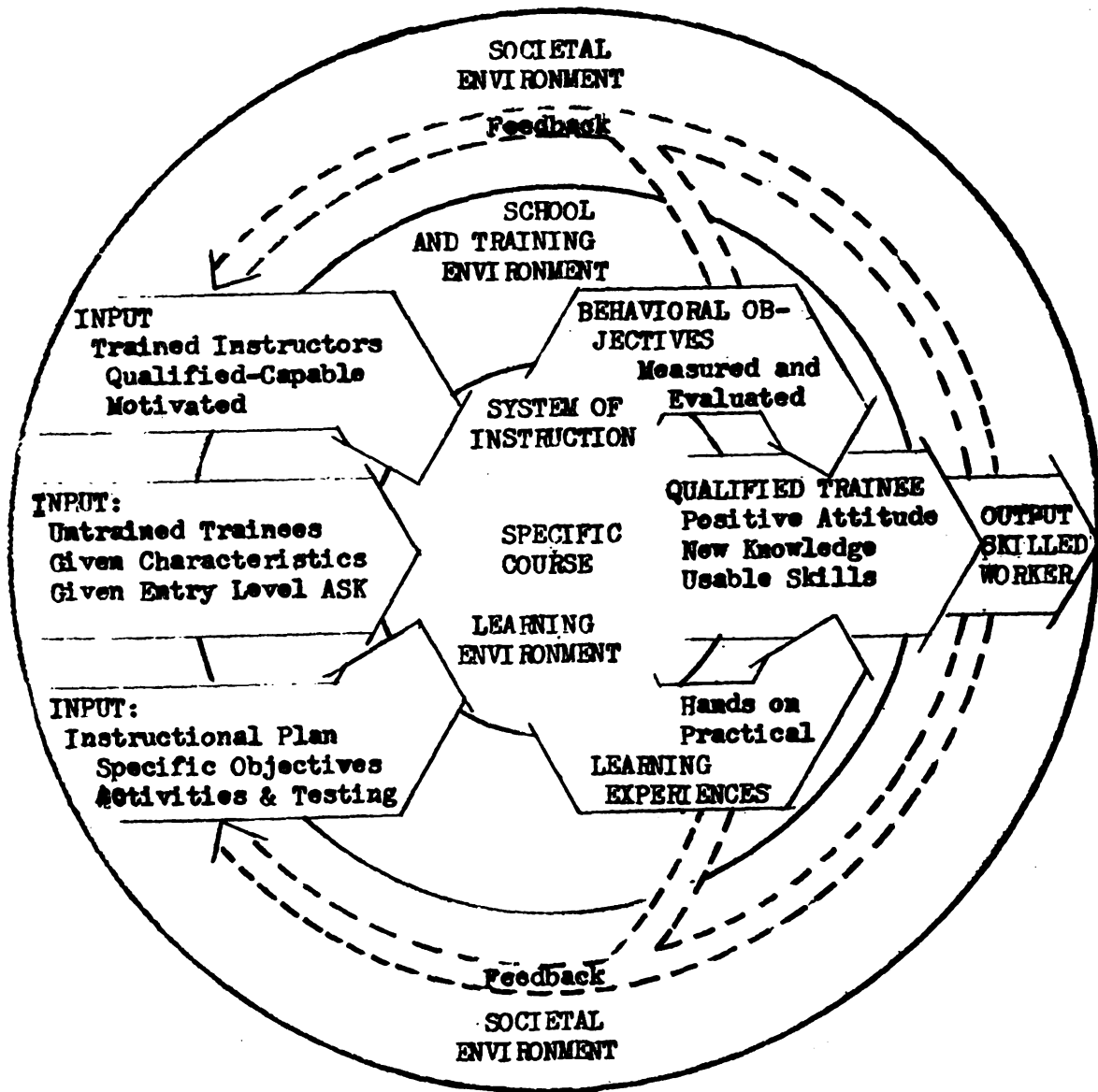


Figure 3.1.--Conceptual Model of MSLATE for developing occupational training programs for educationally deprived and disadvantaged youth and adults in developed and developing countries.

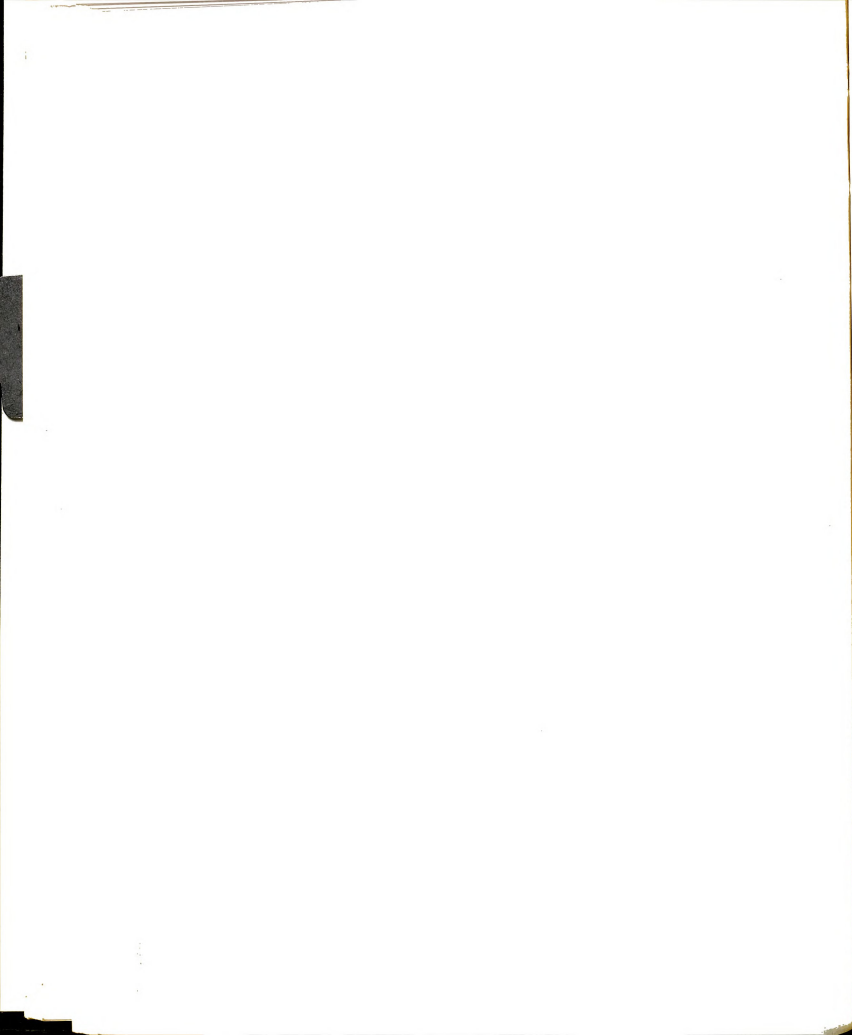
also imposes constraints within which the learning system must operate. The resources available outside its immediate environment are limited. Thus, the learning system is judged by its environments by the way it uses these resources, of which man is the most important.

A learning system constantly undergoes change as it attempts to meet the needs and potential of a dynamically growing individual, particularly if he starts at a very low level with high potential. Modification becomes a constant rather than an exception as the system strives to keep up with change, both within itself and with other outside systems impinging upon it.

Initially the training program was conceived as a fairly stable, structured, and well-defined input into an environment. Once it is developed, however, it is constantly molded to meet a particular objective or need. The designers thus called the Basic Tractor Operators' Course a Modified Structured Learning and Training Environment or MSLATE. This is not an original concept but it is unique in its application to manpower training with low-education level and disadvantaged trainees.

The Design of a Measurable Instructional System

The system's approach to decision making provided the structured and orderly design, development, and change of the learning system. The objectives of the system



determined what must be done to attain the training objectives. The design was implemented and the output tested by measures formulated by the behavioral objectives. The test findings were interpreted to evaluate the extent individual objectives were reached. When necessary, the system was redesigned to achieve each objective.

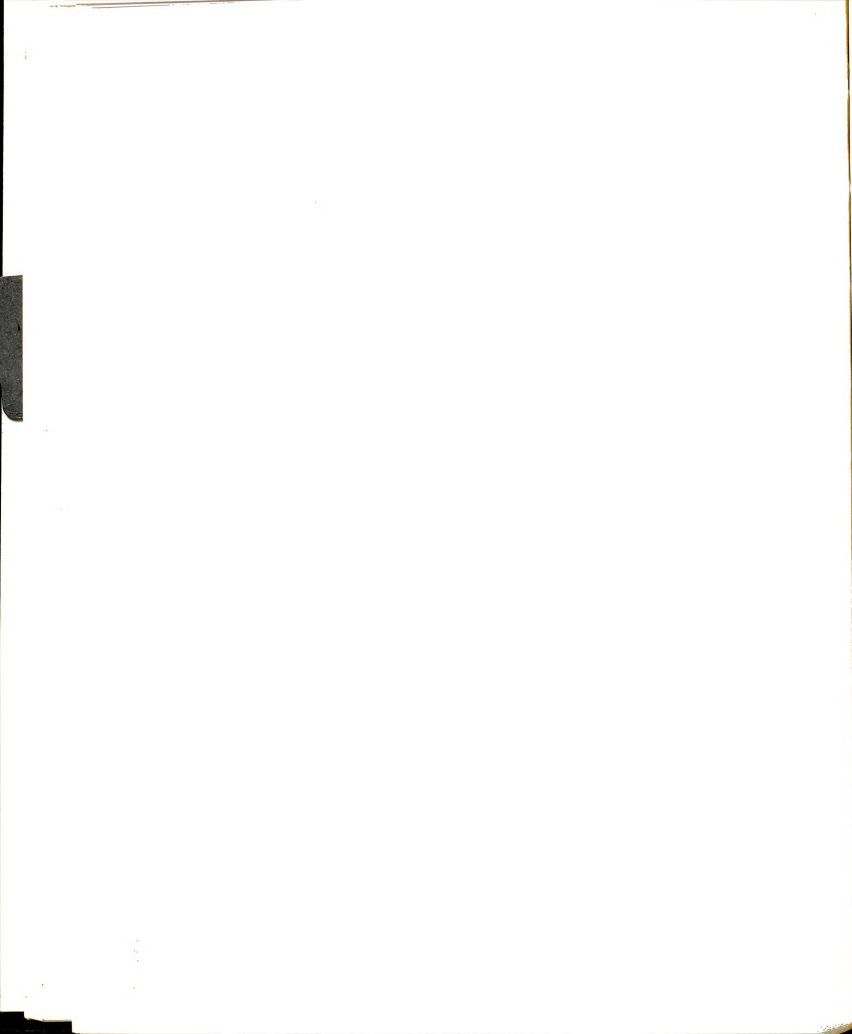
These steps are charted in Figure 3.2 and also described by Banathy (1968, p. 29).

1. A written statement was formulated describing what the learner is expected to do, know, and feel as a result of his learning experiences. (Formulate Objectives.)

2. A criterion test was developed based on objectives and used to test terminal proficiency. (Develop Test.)

3. It was determined what must be learned by the trainee to behave in the way prescribed by the objectives. In this analysis, the input capabilities of the learner were assessed to avoid redundant learning (Analysis of Learning Task).

4. Alternatives were considered and keypoints identified to enable the learner to master the tasks (Functions Analysis). It was decided who or what had the best potential to accomplish these functions (Component Analysis). Schedules were prepared to show when and where the functions were to be enacted (Systems Design).



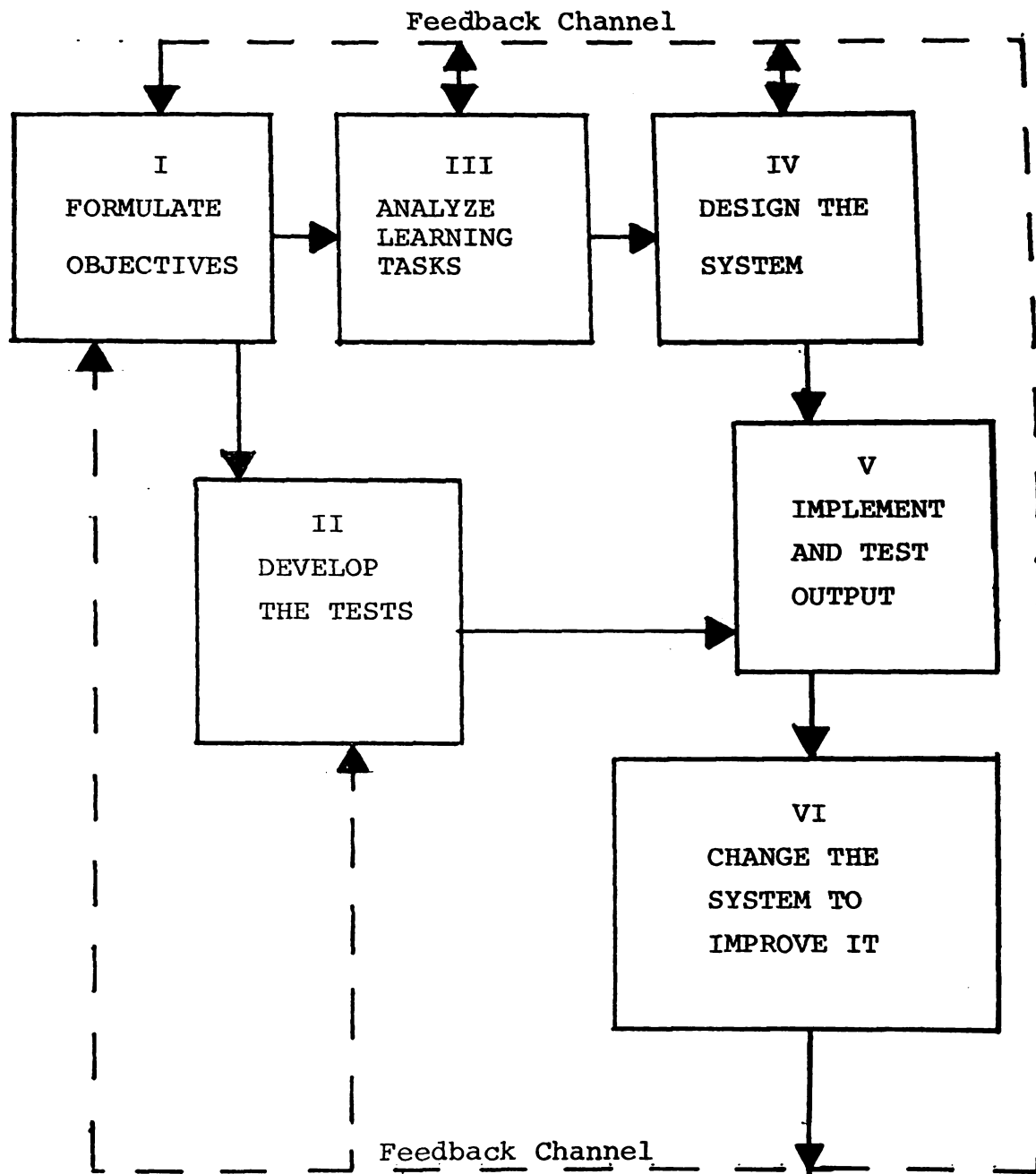
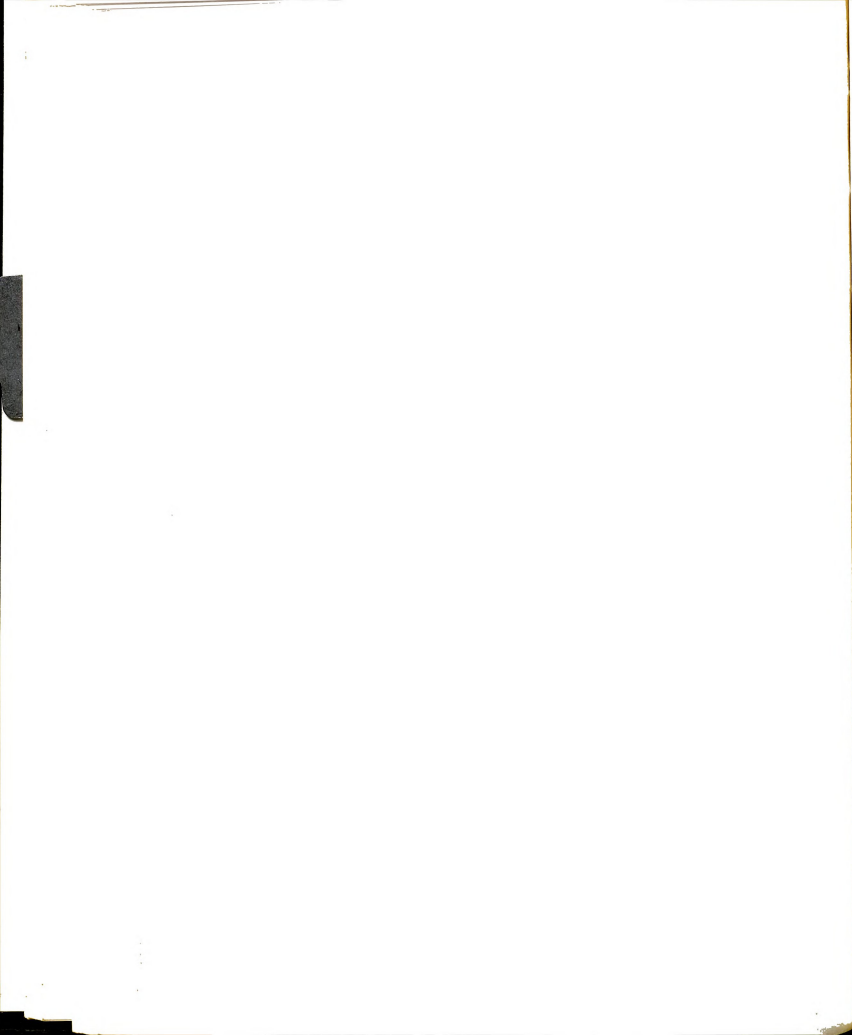


Figure 3.2.--An Over-all Structure of the Design of an Instructional System (after Banathy).

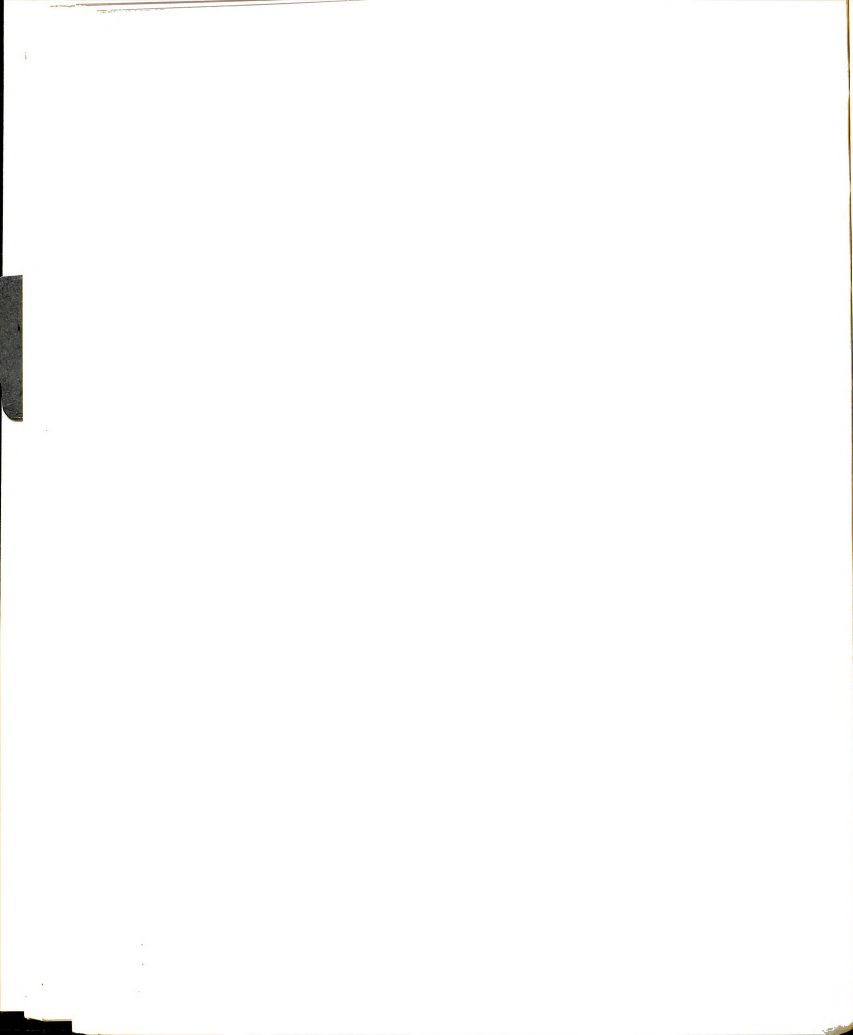


5. The designed system was tried out and tested, implemented and installed. The performance of the learner was evaluated to assess the degree he behaved in the way predicted by the objectives. (Implement and Test Output.)

6. The findings of the evaluation were fed back into the system to adjust it and make any changes needed to improve its performance and output. (Change to Improve.)

More explicit functions that were carried out in designing a measurable instructional system, described above, are presented in the expanded model shown in Figure 3.3.

In Step 4 the distribution of functions among components was considered. Only components which accomplished specific educational functions were used. Given a specific function, the problem was to select from alternative means the one having the best potential to carry out the function. Banathy (1968, p. 64) stated that "one of the rules of component analysis is that the component should fit the function and not the function the component." In the Basic Tractor Operators' Course the best component was selected, based on practicability and economy, from the various alternatives after considering the limitations and constraints inherent in the system environment illustrated in Figure 3.1.



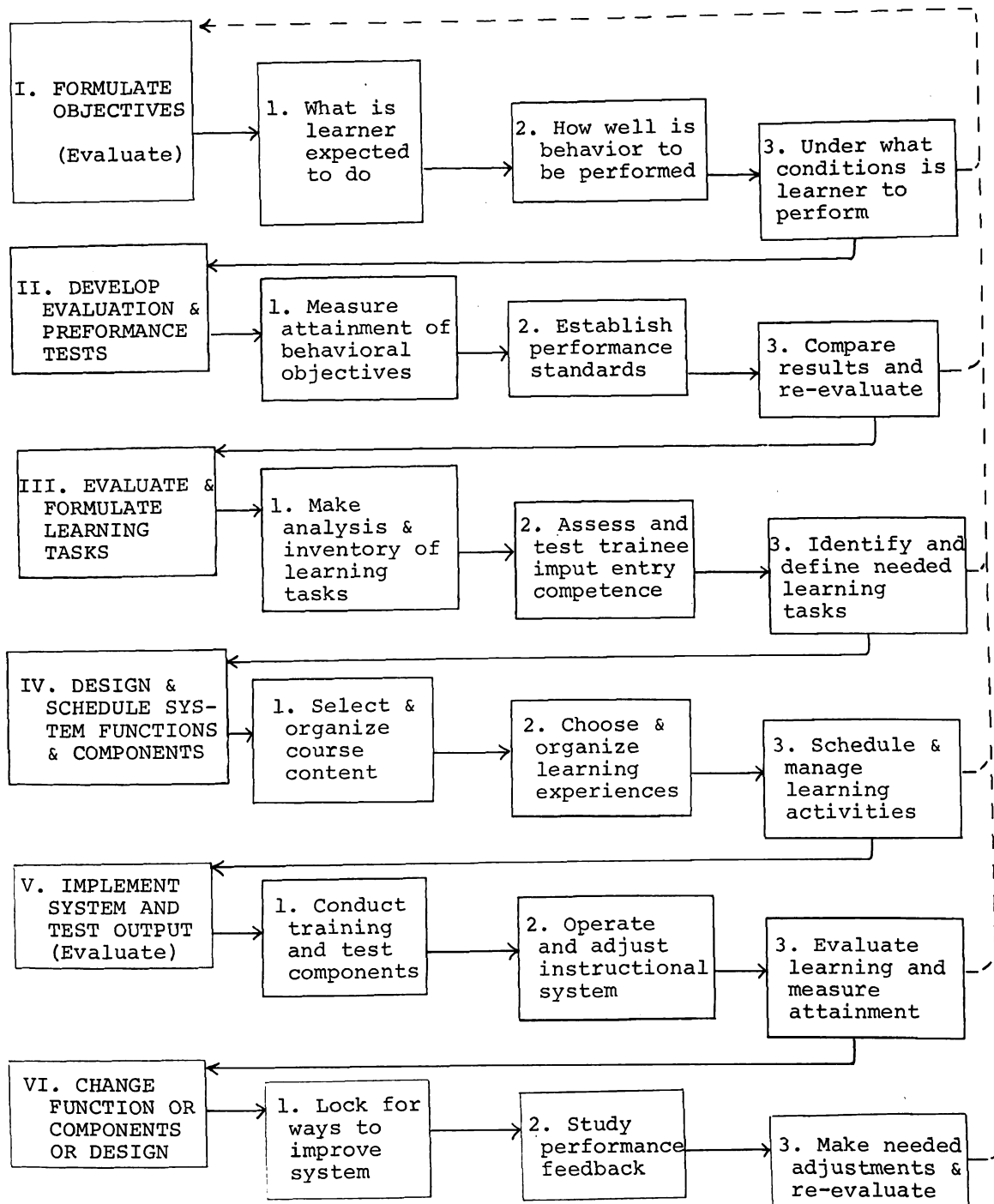
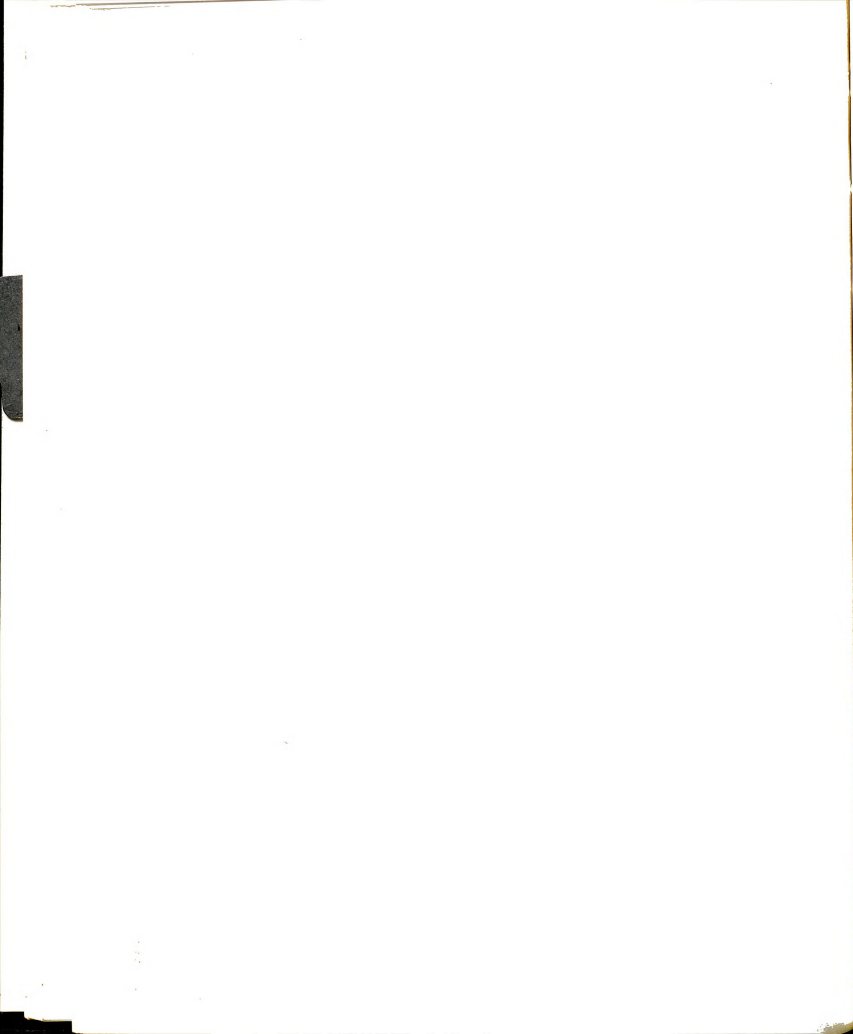


Figure 3.3.--Designing a Measurable Instructional System.



Building a Training Program to Fit Trainee Needs with PERT

The BTOC was analyzed by the Program Evaluation Review Technique (PERT). This sequence represented the most logical order of events. This is important in the development of a PERT network diagram where activities are important time-consuming elements. The network showed which events must precede others, which may be accomplished simultaneously, and which must follow others.

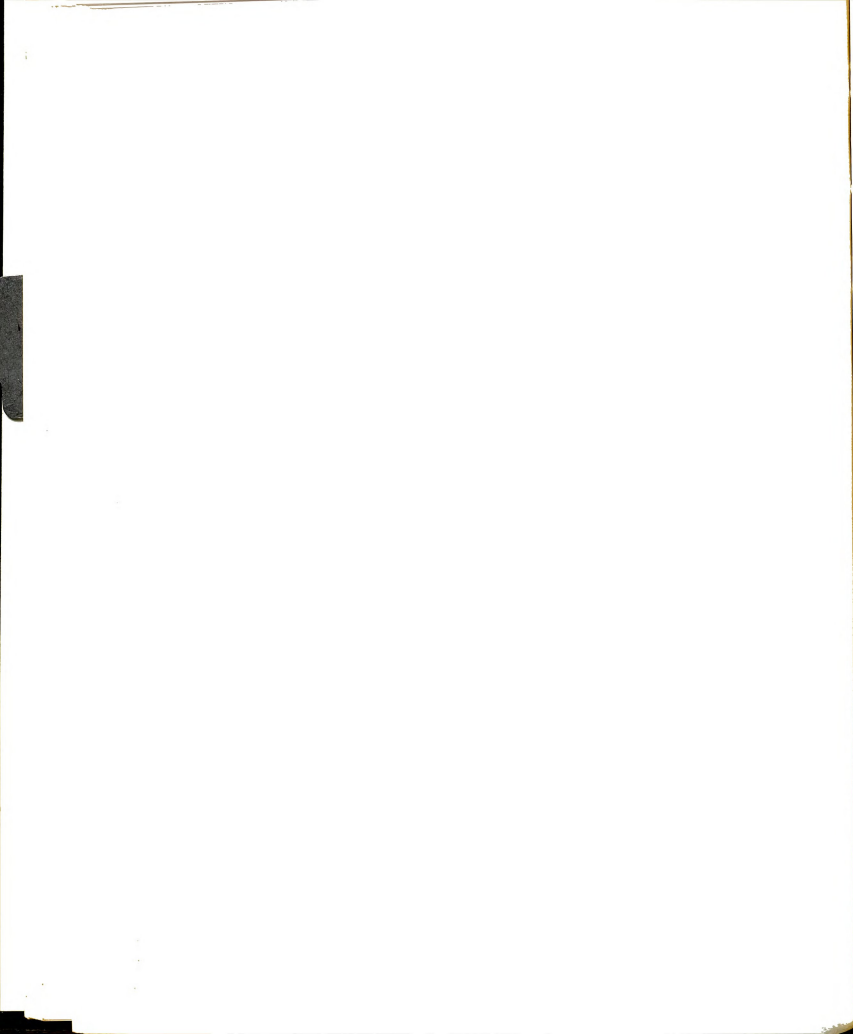
The graphical representation of this model helped the training director design, implement, test and re-evaluate the training program. In Figure 3.3 there is a critical path but it was not included in this simplified diagram. All steps are included but there may be several ways of varying time and resource inputs for each step, determining the critical path for optimum training or cost effectiveness.

Statement of Training Goals and Objectives

Identify the Occupational Cluster "Machinery Operators"

Characteristics of machinery operators with job classification of "Driving-Operating" (D.O.T. Code 0.883).

1. Job Functions Related to Data, People and Things. The worker traits related to Data and People are insignificant for Driving-Operating but are significant



to things at "level 3" which is described by the Dictionary of Occupational Titles (D.O.T.)

Driving-Operating: Starting, stopping, and controlling the actions of machines or equipment for which a course must be steered, or which must be guided, in order to fabricate, process, and/or move things or people. Involves such activities as observing gauges and dials; estimating distances and determining speed and direction of other objects; turning cranks and wheels; pushing clutches or brakes; and pushing or pulling gear lifts or levers. Includes such machines as cranes, conveyor systems, tractors, furnace charging machines, paving machines and hoisting machines. Excludes manually powered machines, such as handtrucks and dollies, and power assisted machines, such as electric wheelbarrows and handtrucks.

2. Machine Work Types of Jobs. In machine work involving Driving and Operating, the D.O.T. (p. 444) defines the work performed, worker requirements, relating clues, typical training, and methods of job entry.

Work Performed

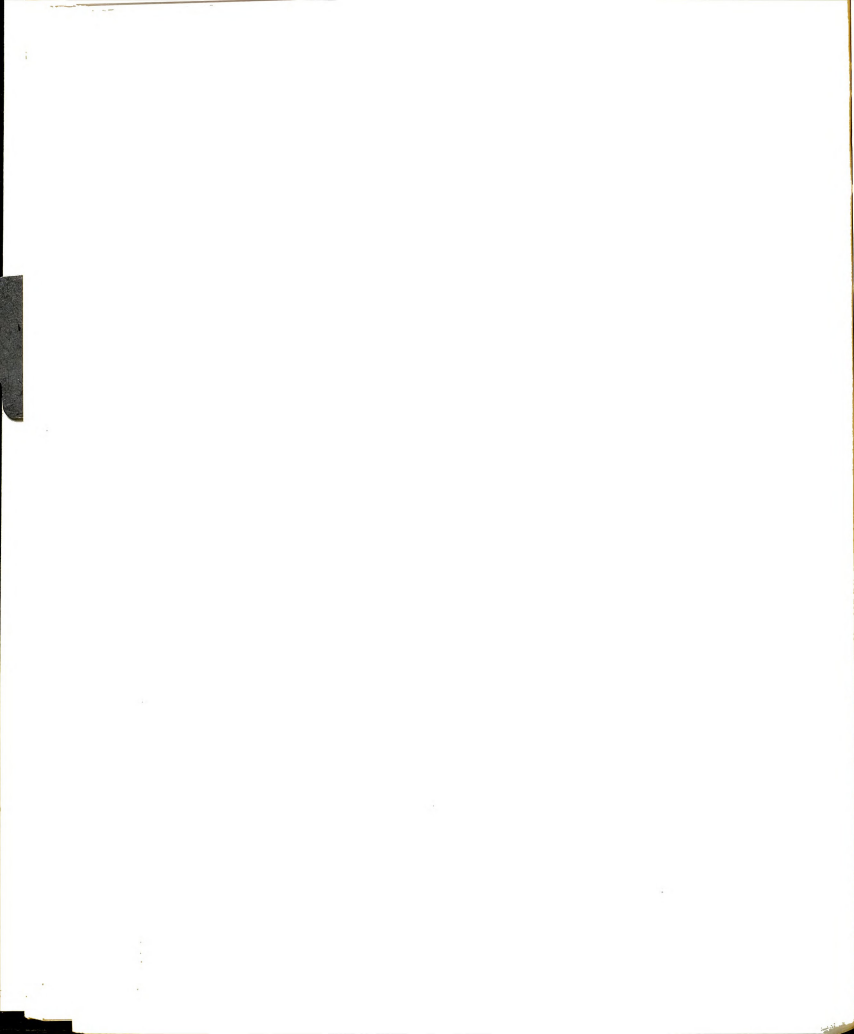
Work activities in this group primarily involve starting, stopping, and moving the controls of machines which must be steered or guided in order to fabricate, process, and/or move materials and products. The work is occasionally performed at the given signals of others. Typical machines are farm tractors, trucks, hoisting machines and charging machines which pave roads, transport people or materials, hoist building supplies, and charge ore into furnaces.

Worker Requirements

An occupationally significant combination of: Spatial discrimination; eye-hand-foot coordination; manual dexterity; a preference for working with machines and equipment; the ability to follow instructions; and facility in adapting to routine, repetitive work.

Clues for Relating Applicants and Requirements

Considerable driving experience.
Military experience driving tank, truck, or similar vehicle.
Good vision and general physical condition.
Casual work experience driving truck or farm machine.



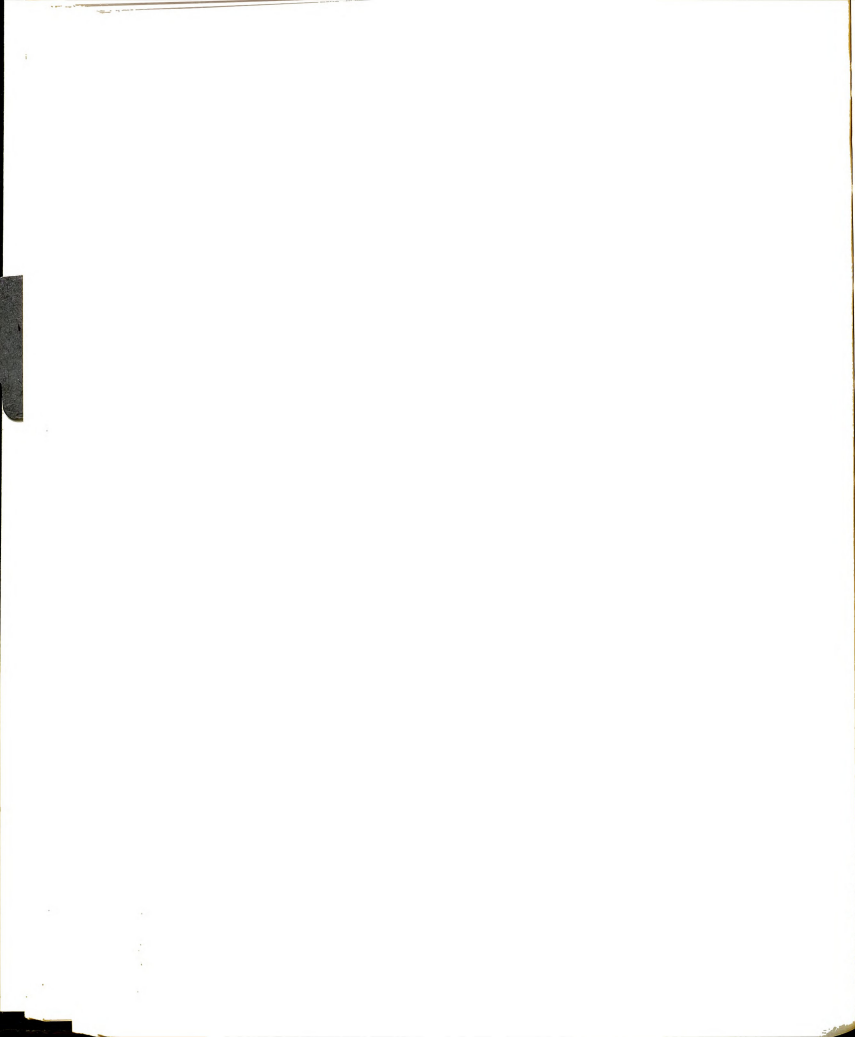
Training and Methods of Entry

Entry into these activities is usually by interest and possession of necessary physical abilities. Casual work experience and other types of exposure to situations involving moving machines can be considered an indication that this might be suitable work. On-the-job training is the usual method by which workers acquire proficiency.

Definition of a specific type of machine operator.--

The D.O.T. lists two job classifications which include the agricultural machinery operator. The "farm equipment operator" (p. 264) and the "tractor operator" (p. 749) are described similarly but the former implies tractor use with some other specialized farming tool as a power and implement system.

FARM-EQUIPMENT OPERATOR (agric.) 409.883. Drives and controls farm equipment to till soil and to plant, cultivate, and harvest crops: Hitches soil conditioning implement to tractor and operates tractor and towed implement to furrow and grade soil. Drives tractor and operates designated towed equipment to plant, fertilize, dust, and spray crops. Prepares harvesting machine by adjusting speeds of cutters, blowers, and conveyors and height of cutting head or depth of digging blades according to type, height, weight, and condition of crop being harvested, and contour of terrain. Attaches towed- or mounted-type harvesting machine to tractor, using handtools, or drives harvesting machine to cut, pull up, dig, thresh, clean, chop, bag, or bundle crops. When towing or driving machine to perform combined harvesting operations, may be designated COMBINE OPERATOR. May drive team to pull farm equipment and be designated TEAMSTER. May operate and maintain several types of farm equipment and be designated ALL-AROUND FARM-MACHINERY OPERATOR. May be designated according to crop specialty and farm equipment operated as BEAN-FIELD WORKER; CORN-PICKER OPERATOR; DISK-PLOW OPERATOR; TRACTOR OPERATOR. See Volume II for additional titles.



TRACTOR OPERATOR (agric.) see FARM-EQUIPMENT OPERATOR.
 --(any ind.) 929.883. Drives gasoline or diesel powered tractor to move materials, draw implements, pull out objects imbedded in ground, or pull cable of winch to raise, lower, or load heavy material or equipment: Fastens attachments, such as graders, plows, and rollers to tractor with hitchpins. Releases brake, shifts gears, and depresses accelerator or moves throttle to control forward and backward movement of machine. Steers tractor by turning steering wheel and depressing brake pedals. May lubricate and repair tractor and attachments. May be designated according to type of power utilized as DIESEL-TRACTOR OPERATOR; GASOLINE TRACTOR OPERATOR; or according to type of attachment as LIFT-SCOOP TRACTOR OPERATOR.

Worker traits group: driving-operating (D.O.T.

929.883).--Using the worker traits group of "driving-operating," the D.O.T. (Vol. II, p. 652) defines in a qualifications profile the characteristics and levels of education, aptitude, interest, temperments and physical demands that most tractor operators should have to insure successful job performance.

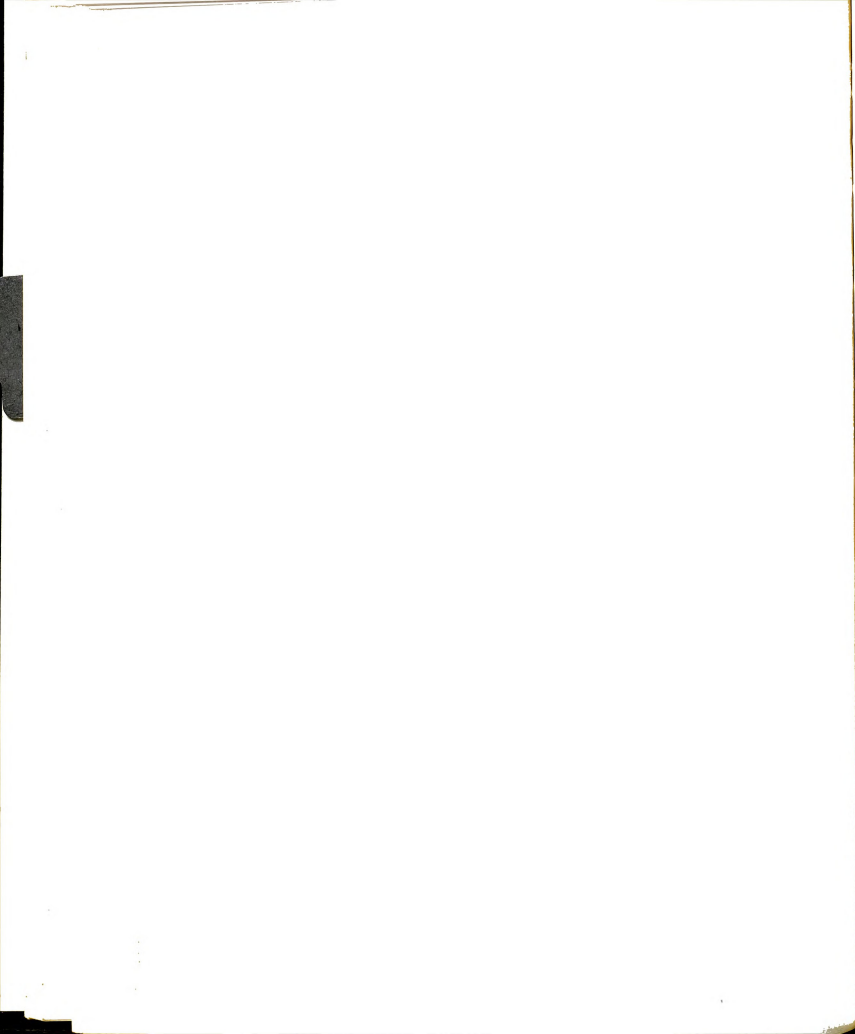
1. General Education Development. Level 3 is preferred but 2 is acceptable. (See chart below for an explanation of these levels of general education.)

2. Level of Specific Vocational Preparation.

Level 4 is recommended with 3 or 5 acceptable where

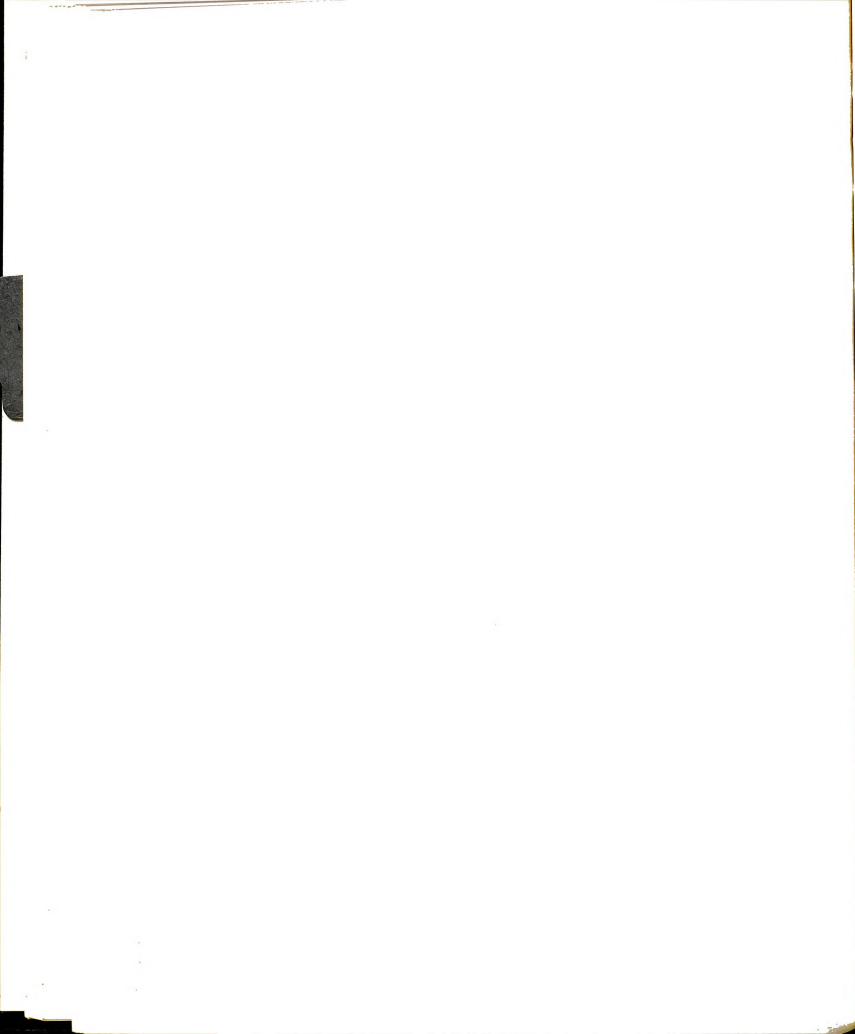
- 4 = over 3 months up to and including 6 months
- 3 = over 30 days up to and including 3 months
- 5 = over 6 months up to and including 1 year.

The D.O.T. (p. 652) defines Specific Vocational Preparation as:



Critical Levels of General Education Development
(D.O.T. Vol. II, p. 652)

Level	Reasoning Development	Mathematical Development	Language Development
3	Apply common sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deal with problems involving several concrete variables in or from standardized situations.	Make arithmetic calculations involving fractions, decimals and percentages.	Comprehension and expression of a level to --File, post, and mail such material as forms, checks, receipts, and bills. --Copy data from one record to another, fill in report forms and type all work from rough draft or corrected copy. --Interview members of household to obtain such information as age, occupation, and number of children, to be used as data for surveys, or economic studies. --Guide people on tours through historical or public buildings, describing such features as size, value, and points of interest.
2	Apply common sense understanding to carry out detailed but uninvolved written or oral instructions. Deal with problems involving a few concrete variables in or from standardized situations.	Use arithmetic to add, subtract, multiply, and divide whole numbers.	



The amount of time required to learn the techniques, acquire information, and develop the facility needed for average performance in a specific job-worker situation. This training may be acquired in a school, work, military, institutional, or avocational environment. It does not include orientation training required of even every fully qualified worker to become accustomed to the special conditions of any new job. Specific vocational training includes training given in any of the following circumstances:

- a. Vocational education (such as high school commercial or shop training, technical school, art school, and that part of college training which is organized around a specific vocational objective);
- b. Apprentice training (for apprenticeable jobs only);
- c. In-plant training (given by an employer in the form of organized classroom study);
- d. On-the-job training (serving as learner or trainee on the job under the instruction of a qualified worker);
- e. Essential experience in other jobs (serving in less responsible jobs which lead to the higher grade job or serving in other jobs which qualify).

Aptitude levels needed.--Aptitude levels are considered occupationally significant for the specific group, i.e., essential for average successful job performance. While not all of them are necessarily required for each job, some combination of them is essential in every case according to the D.O.T. (Vol. II, p. 652) where

for Intelligence (G), Verbal (V) and Numerical (N):

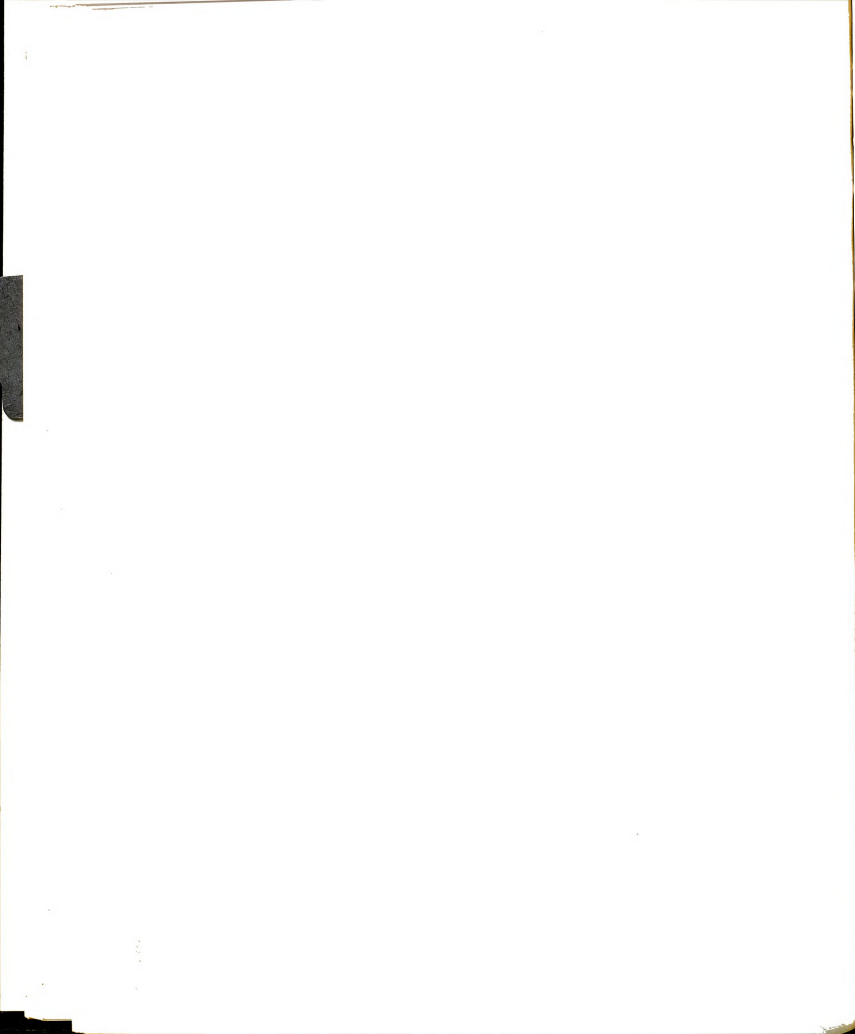
$$G = 3, V = 4, N = 4$$

for Spatial (S), Form Perception (P) and Clerical Perception (Q):

$$S = 3, P = 4, Q = 5$$

for Motor Condition (K), Finger Dexterity (F), and Manual Dexterity (M):

$$K = 3, F = 4, M = 3$$



for Eye-hand-foot Coordination (E) and Color
Discrimination (C):

E = 3, C = 5 (not significant)

where Aptitude level 3 = middle third of population with a median degree of aptitude

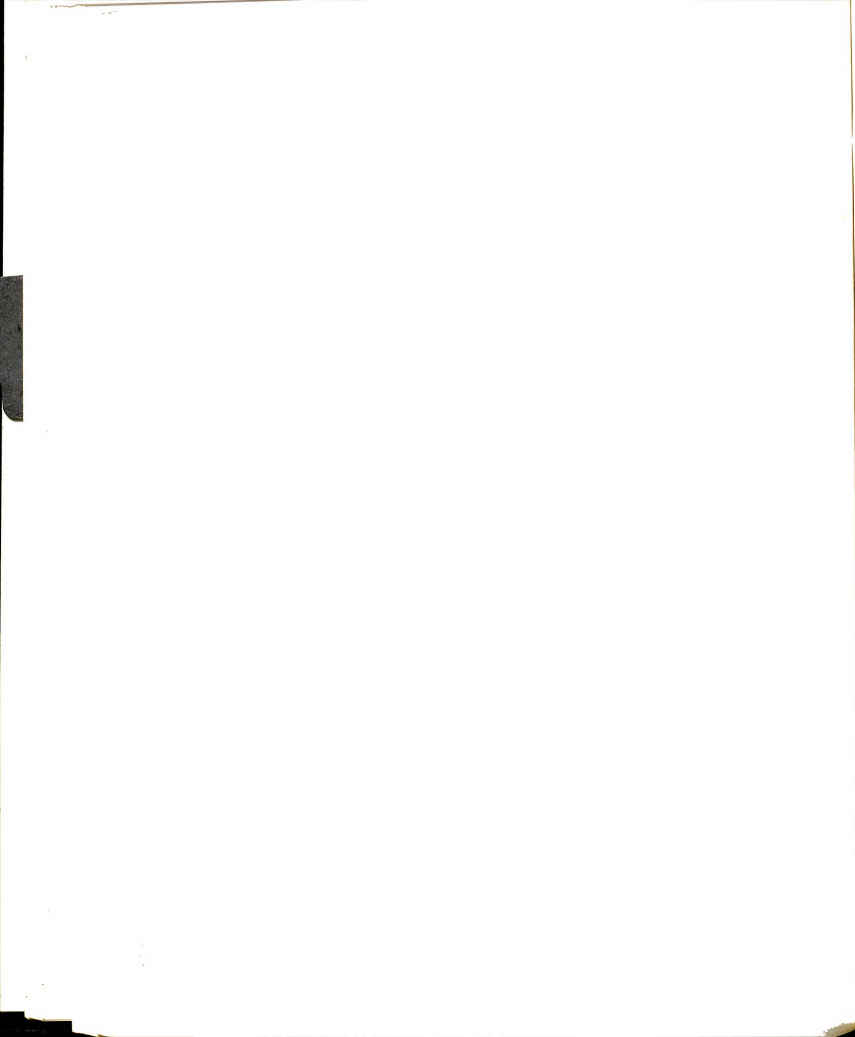
where Aptitude level 4 = lowest third of population exclusive of bottom 10 % with a low degree of aptitude

where Aptitude level 5 = lowest 10 % of population with a negligible degree of the aptitude.

Interest level desired.--Interest level for most successful operation was defined by D.O.T. (Vol. II, p. 654) with levels 1, 9, and 3 significant.

Preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences. Five pairs of interest factors are provided so that a positive preference for one factor of a pair also implies rejection of the other factor of that pair.

- | | | | | |
|---|---|-----|---|---|
| 1 | Situations involving a preference for activities dealing with things and objects. | vs. | 6 | Situations involving a preference for activities concerned with people and the communication of ideas. |
| 2 | Situations involving a preference for activities involving business contact with people. | vs. | 7 | Situations involving a preference for activities of a scientific and technical nature. |
| 3 | Situations involving a preference for activities of a routine, concrete, organized nature. | vs. | 8 | Situations involving a preference for activities of an abstract and creative nature. |
| 4 | Situations involving a preference for working for people for their presumed good, as in the social welfare sense, or for dealing with people and language in social situations. | vs. | 9 | Situations involving a preference for activities that are nonsocial in nature, and are carried on in relation to processes, machines, and techniques. |



- | | | |
|---|---------------|--|
| 5 Situations involving a preference for activities resulting in prestige or the esteem of others. | <u>vs.</u> 10 | Situations involving a preference for activities resulting in tangible, productive satisfaction. |
|---|---------------|--|

Temperaments.--The occupational demands to which these workers must adjust are levels 2, 3, and Y involving situations where

2 = Repetitive or short cycle operations carried out according to set procedures or sequences

3 = Doing things only under specific instruction, allowing little or no room for independent action or judgment in working out job problems

Y = The precise attainment of set limits, tolerances, or standards.

Physical demands.--Those physical activities required of a worker on the job labeled L, M, H, 2, 3, 4 and 6 where

L, M & H = Light, medium and heavy lift, carry, push, or pull of 20 to 100 lbs. maximum

2 = Climb and balance

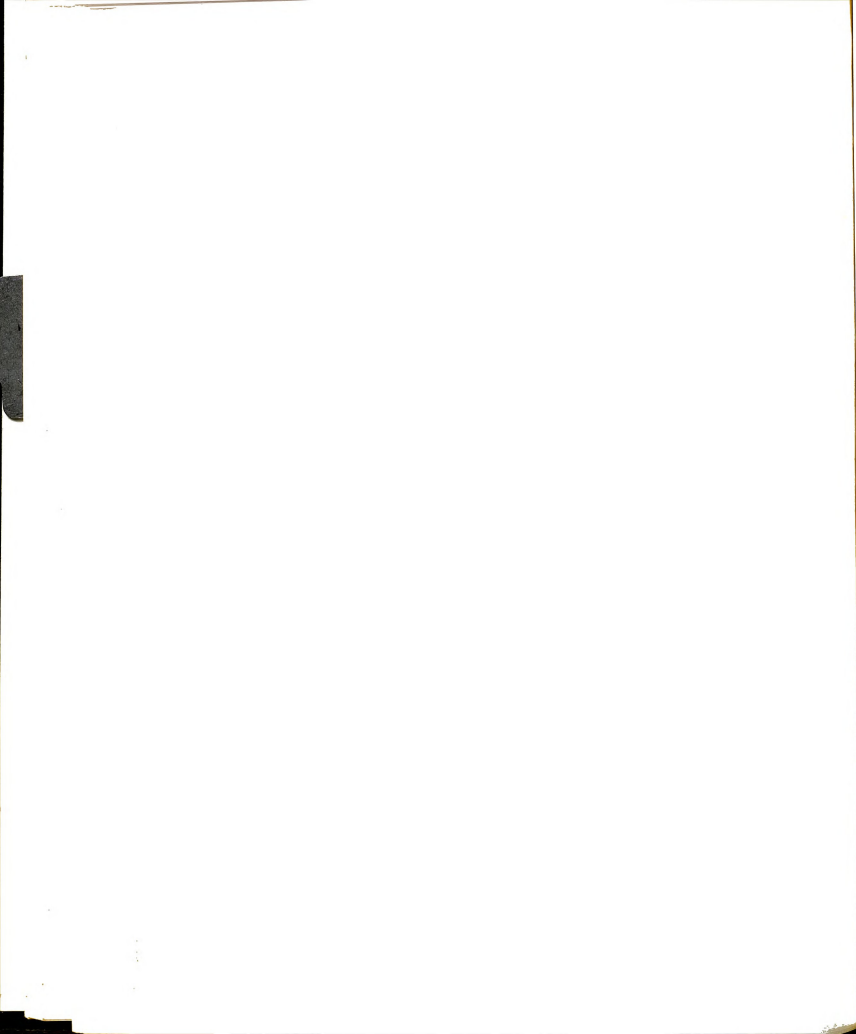
3 = Stoop, kneel, crouch, and crawl

4 = Reach, handle, finger, and feel

6 = See (acuity, depth perception, field of vision, and accomodation)

Define Job Competencies Needed by Tractor Operators

After the training need was established it became necessary to specify the competencies needed by the job for which training is being offered. These competencies



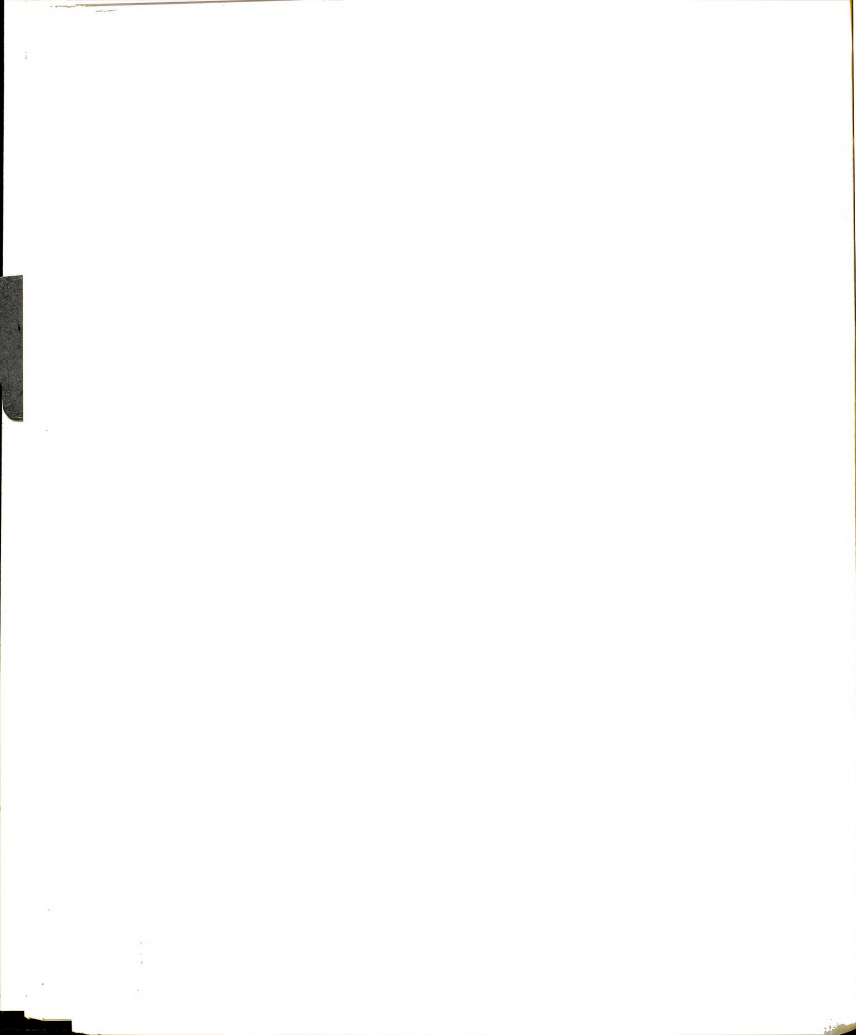
will vary with the type of job and the desired proficiency level. A job description is one means of describing these competencies. This description included the skills, knowledge, and attitudes necessary for successful job performance. It also defined the upper and lower limits of job performance.

This program was designed to train a Basic Tractor Operator, Grade I, as defined below. Grade II and Grade III operator descriptions are also included to illustrate how the basic operator can advance to higher skills. These operators will need further training and experience.

The Grade I tractor operator will be qualified to work under the supervision of an owner or supervisor of tractor operators. He will operate a tractor with a plow, harrow or trailer efficiently and with safety for himself and the equipment. He will perform daily and weekly maintenance on the tractor and associated equipment and operate the tractor lawfully on public roads. He will not be qualified to perform maintenance beyond the 50-hour checks stated in the owners manual, make major adjustments or repairs on the tractor or make managerial decisions concerning the use of the tractor.

The Grade II operator will be a more advanced operator or owner-operator requiring greater self-reliance. He will be qualified to perform additional maintenance and care of the tractor, including some minor adjustments and repair. Instruction will be carried out on the use of additional tools and implements and the use of PTO and belt pulley supplemental power systems.

The Grade III operator will cover all tractor preventative maintenance and lubrication services through 1000 hours, the operation, adjustment, and care of major tools and implements used in the area. Skills and knowledge will be developed sufficient for independent operation of the equipment. This operator will make all minor adjustments, carry out simple repairs and make managerial decisions contributing to the wise and efficient use of the tractor and its associated implements and tools.



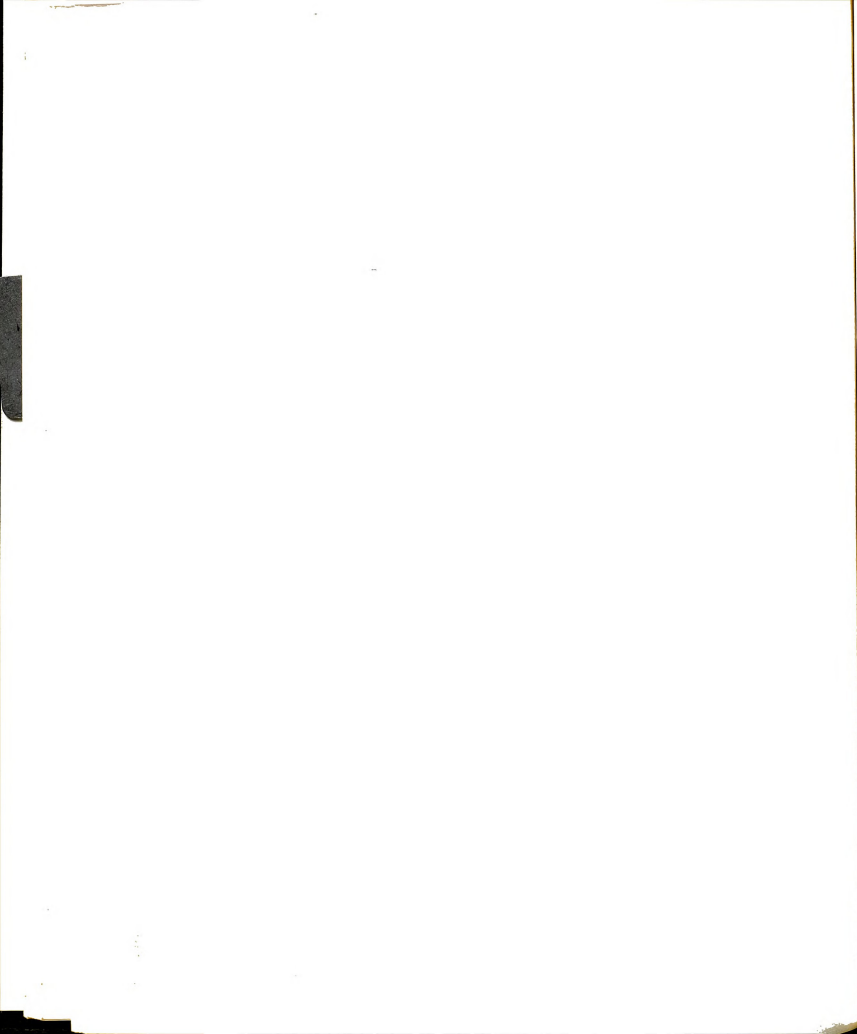
A qualified tractor "operator" is more than a skillful "driver." A good driver can handle and maneuver the tractor skillfully without implements. He can operate a tractor lawfully on public roads. He knows, understands, and practices good driving habits and obeys traffic regulations and rules. He knows the functions of the major controls on the tractor and can use them efficiently to regulate the action of the tractor. A tractor "operator" also has the following attitudes, skills and knowledge:

Attitudes:

1. Likes machines and wants to learn to use them properly.
2. Is reliable.
3. Is conscientious and does his best.
4. Shows pride by keeping his machines clean and in good condition.
5. Takes pride in doing quality work.
6. Is not ashamed to ask questions and calls a mechanic or supervisor to do things for which he has not been trained.
7. Uses every opportunity to improve himself.

Skills:

1. Uses all controls of the tractor and selected implements.
2. Performs prescribed daily and weekly maintenance services.

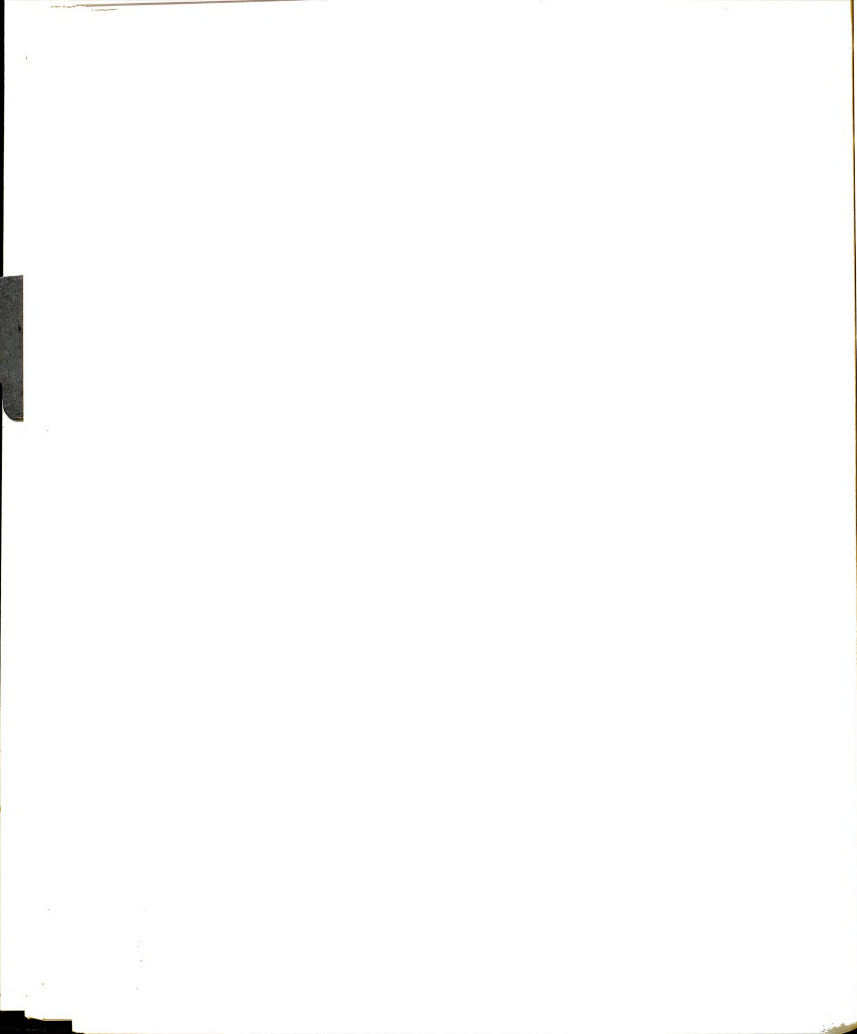


3. Checks and adds the proper amounts of pre-selected fuel, oil, and water.
4. Hitches and unhitches selected implements to the tractor 3-point hitch or drawbar.
5. Selects proper gear and throttle settings for load, task, weather, and field conditions.
6. Manipulates the tractor safely and skillfully around the farm and on public roads with and without implements.
7. Makes simple preliminary and field adjustments to implements for proper operation.

Knowledge:

1. Can explain elementary principles of tractor operation, internal combustion engine, gears, power transmission, and lubrication.
2. Understands safety rules pertaining to tractor operation in the field or on the road.
3. Knows the governmental regulations concerning tractor operation on public roads.
4. Distinguishes quality work from inferior work when plowing, weeding, hauling, etc.
5. Recognizes need to call a mechanic or supervisor when the tractor or implement is not working properly.

These are a few of the characteristics needed to be a good tractor operator. Specific qualities are stated in the text of the training program as behavioral objectives.



Break Job of Basic Tractor Operator into Separate Tasks

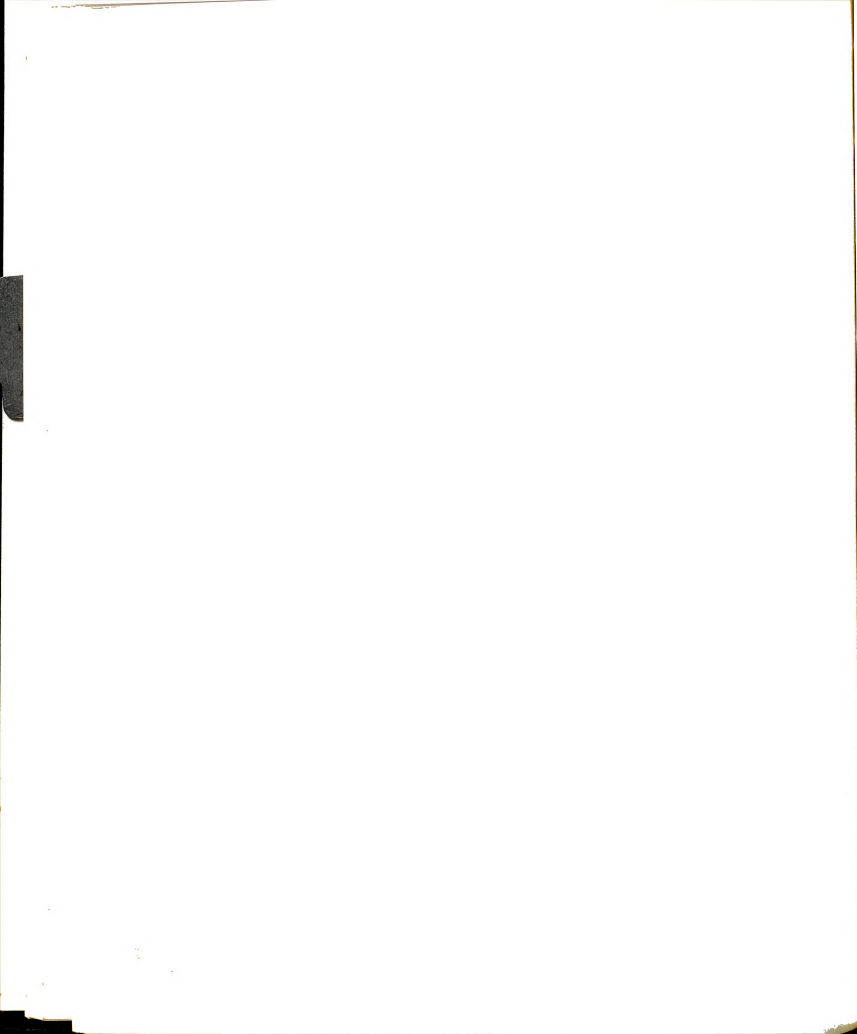
The description for machinery and tractor operators and the definition of a Basic Tractor Operator, Grade I were used to break down the job of the basic tractor operator into key tasks for which the operator was to receive training. They were listed in a logical order for learning acquisition. This list became the general outline for the sequential lesson outline and training schedule. (See Appendix A).

Orientation.

1. Appreciate the importance of a tractor operator.
2. Learn the basic tractor nomenclature.
3. Know the principles of engine care.
4. Understand generally how an internal combustion engine works.
5. Learn the basic ways a tractor is used in farming.
6. Develop a feel for the tractor under motion.
7. Know how power is transmitted by the tractor.
8. Learn correct way to use common hand tools.

Servicing the Tractor.

9. Develop a positive attitude toward tractor care.
10. Learn the system of daily maintenance.
11. Know the importance of the fuel system.
12. Check and add fuel.
13. Check and clean the fuel sediment bowl(s).
14. Know how the air system works.
15. Clean the air precleaner.
16. Check and service the oil-bath air cleaner.
17. Check and service the dry-filter air cleaner.
18. Know how the engine is lubricated.
19. Check and add oil to the crankcase.
20. Grease the tractor.
21. Know how the cooling system works.
22. Check and add water to the radiator.
23. Clean the grill and radiator screens.
24. Check pressure and add air to the tires.
25. Check and tighten the wheel nuts.
26. Check and tighten loose nuts and bolts on tractor.



27. Know how weekly maintenance is performed.
28. Check and add water to the battery.
29. Check and service the electrical system.
30. Keep maintenance records.

Start and Warm the Engine.

31. Learn to observe safety rules around moving machines.
32. Mount the tractor safely.
33. Adjust the tractor seat.
34. Set the controls properly for starting.
35. Warm up the engine properly.
36. Read and interpret the alternator light.
37. Read and interpret the oil pressure light.
38. Read and interpret the water temperature gauge.
39. Read and interpret the speed-hour meter.

Operate the Controls and Maneuver the Tractor.

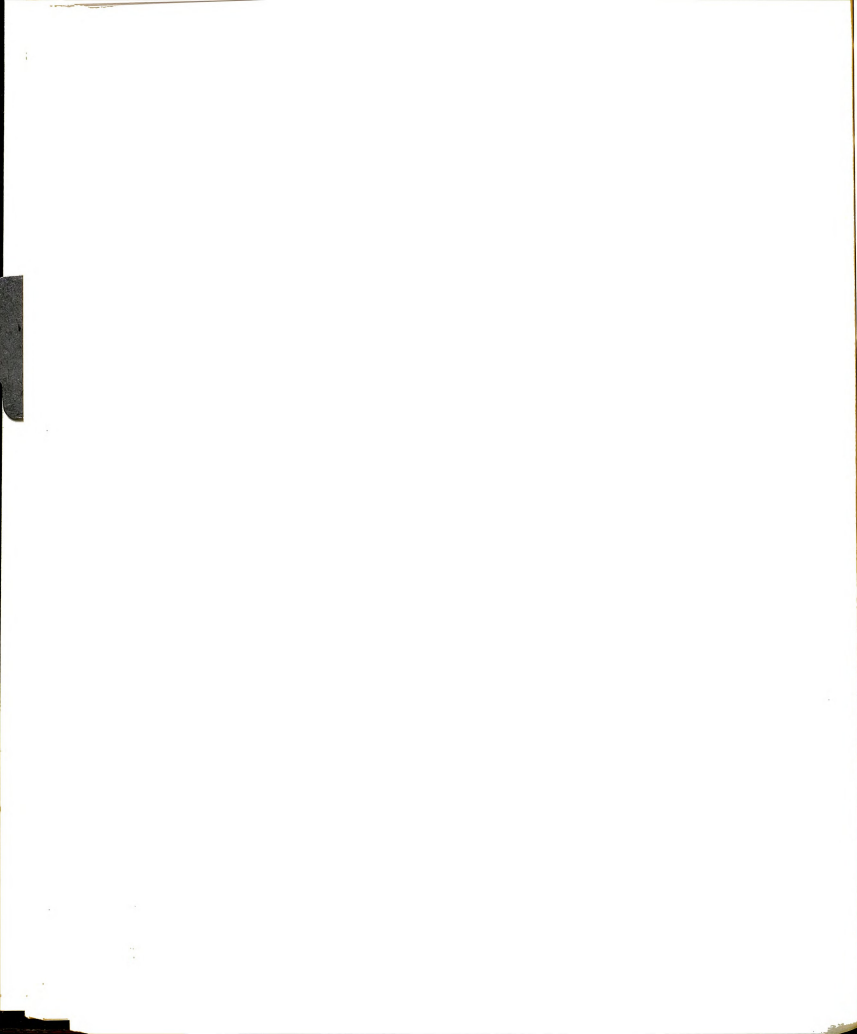
40. Learn driving safety rules.
41. Operate the hand and foot throttles.
42. Operate the clutch properly.
43. Select the transmission gear and range.
44. Steer the tractor.
45. Read the instruments while driving.
46. Use brakes to slow or stop the tractor.
47. Use one brake to turn the tractor.
48. Stop the engine properly.

Managing the Tractor and Using Good Judgment.

49. Park the tractor properly.
50. Operate tractor under difficult conditions.
51. Choose proper gears to avoid overloading engine.
52. Use differential lock to stop wheel spin (if so equipped).
53. Use power shift to increase power on the go (if so equipped).
54. Break in a new tractor correctly.
55. Manage the use of the tractor.
56. Keep accurate operating cost records.
57. Add ballast to reduce wheel slip.
58. Add ballast to increase tractor stability.
59. Learn traffic signs for highway operation.
60. Use hand signals for close maneuvering.
61. Know traffic rules and regulations.

Using the Tractor as a Power Source.

62. Know the tractor's four basic power systems.
63. Hitch an implement to the drawbar.
64. Adjust the tractor drawbar correctly.



65. Use the 3-point hitch controls properly.
66. Hitch an implement to the 3-point hitch.
67. Hitch up a remote controlled hydraulic cylinder.
68. Pull and back a two-wheel trailer.
69. Pull and maneuver a four-wheel wagon.

Safety in Operation.

70. Store and properly care for fuel and lubricants.
71. Practice human safety around machinery.
72. Develop a safety consciousness in operating a tractor.

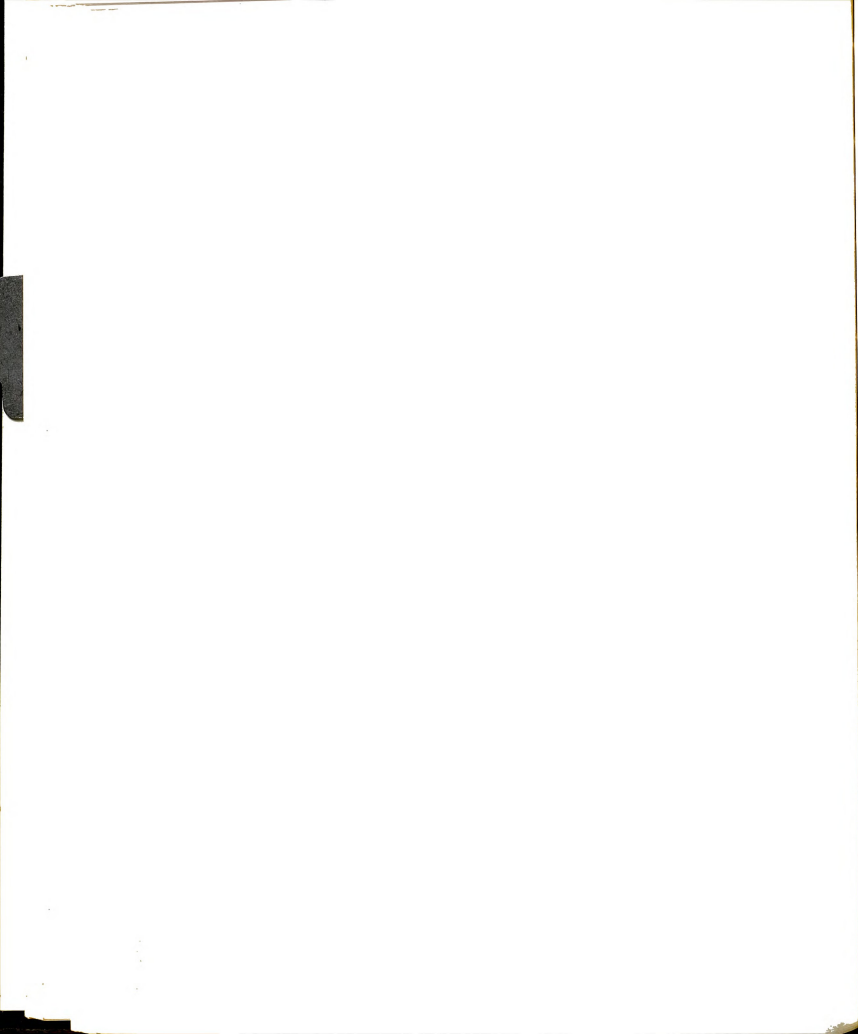
Using Tractor with Implements in Productive Farming Operations.

73. Prepare tractor to hitch to a mounted disk plow.
74. Adjust disk plow for good plowing.
75. Check and service disk plow.
76. Prepare tractor to hitch to a semi-mounted moldboard plow.
77. Adjust moldboard plow for good plowing.
78. Check and service the disk harrow.
79. Prepare tractor hitch for pull-type disk harrow.
80. Adjust disk harrow for field operation.
81. Check and service the disk harrow.
82. Prepare tractor for power-take-off operation.
83. Hitch tractor to a PTO implement.
84. Operate PTO implement properly and safely.
85. Use tractor with other tools or implements as required.
86. Use lights and warning flashers correctly.
87. Transport supplies and equipment over road and field safely.
88. Recognize when tractor needs service by a mechanic.
89. Service the tractor at the end of the day.
90. Prepare implements and tractor for storage after use.

An example of how one of these groups of activities was broken into its separate tasks is shown by Figure 3.5 on the Daily Maintenance Services flow chart.

Analyze Each Task to Determine the Essential Elements

Each task was then analyzed to determine its essential elements and their inter-relationships. Most of



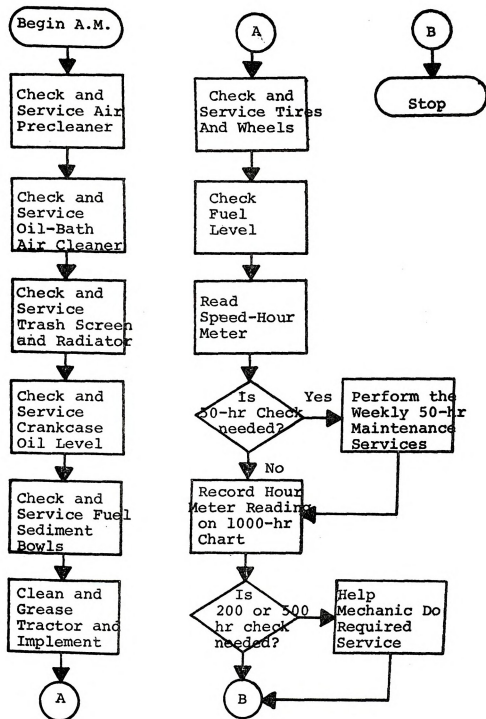


Figure 3.4.--Flow Chart for Lesson B-2: Daily Maintenance Services Before Operation. A Typical Job Function of the Tractor Operator Broken Down Into Task Elements for Analysis.

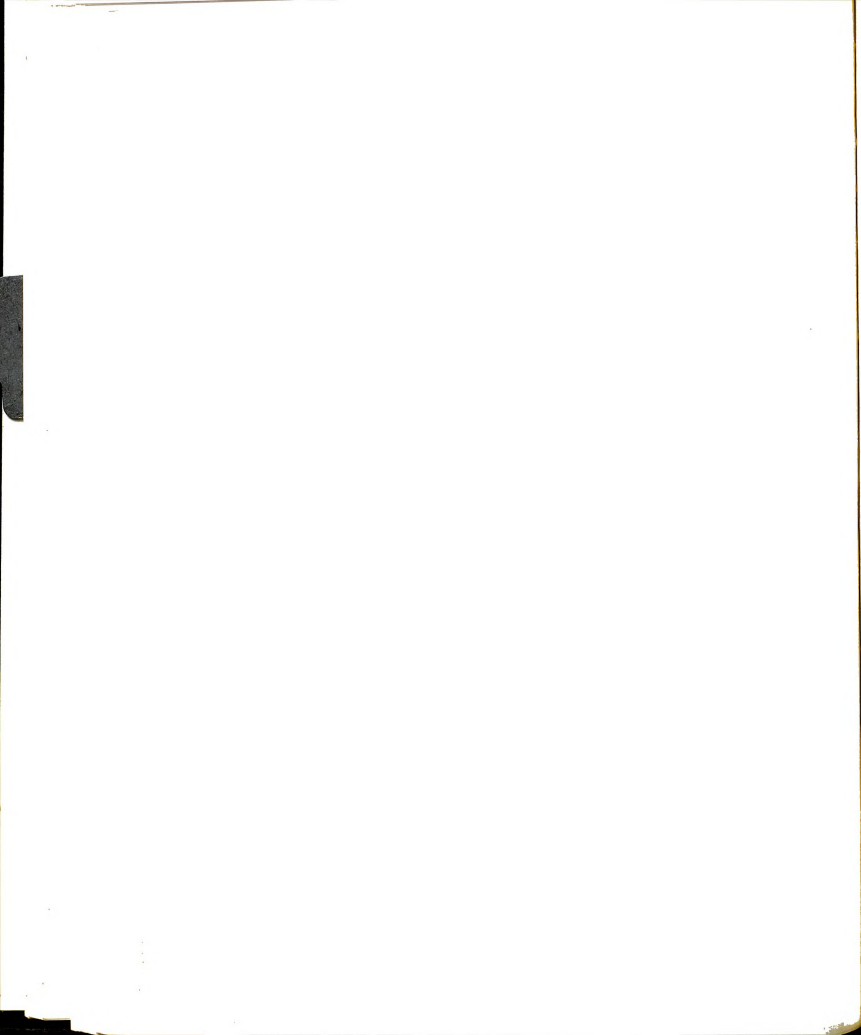
these tasks were studied by observing an expert operator perform the various steps, asking him questions and then writing down each key step in the process, including skills, judgments and actions.

The data obtained in the task analysis were put into a flow chart using the techniques of Critical Path Method (CPM) and Program Evaluation Review Techniques (PERT) combined into the systems engineering approach for problem solving. These flow charts are called "logic trees" by the U.S. Army. They can be simple or complex, depending on the task and level of responsibility.

For an example of a flow chart on Servicing the Dry-Filter Air Cleaner see Figure 3.6 for lesson B-9.

The flow charts were included at the end of each lesson where skills are involved except for the A series of lessons and B-1. They give the step-by-step procedure for carrying out any of the skills. They were included to insure that none of the steps in making and carrying out the knowledge decisions, proper procedure, or performance of the skills were deleted. These flow charts were designed to be used by the instructor in the following ways [(*) items refer to the steps which must be included to meet minimum certification requirements]:

1. As a reference when preparing demonstrations;
2. As a quick reference when presenting the step-by-step procedure to the class;



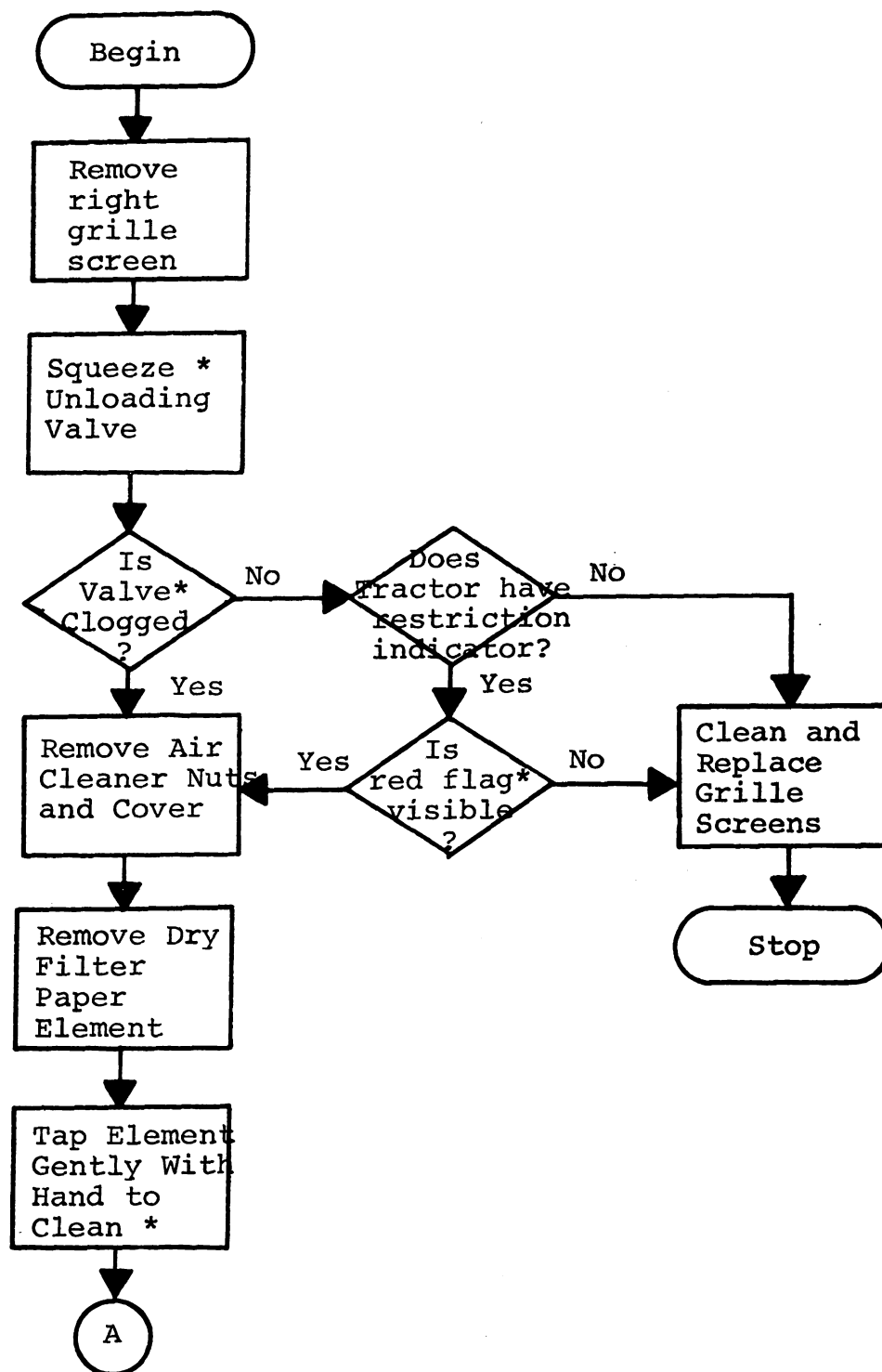
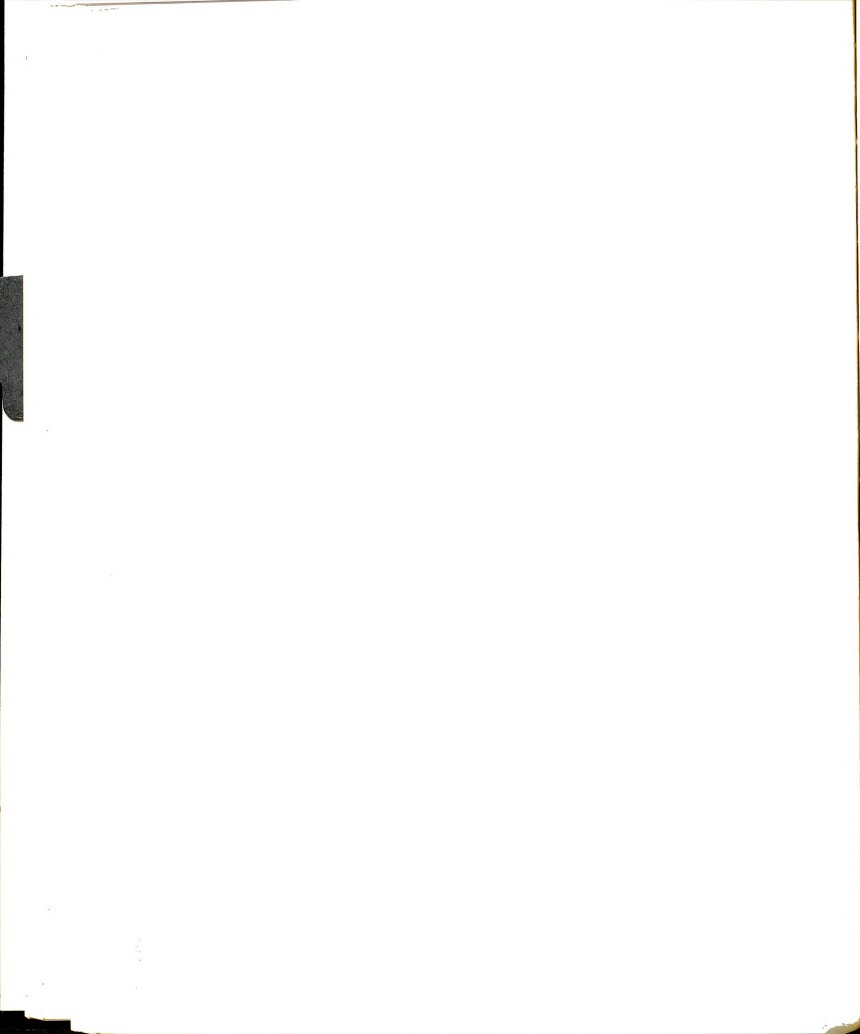


Figure 3.5.--Flow Chart for Lesson B-9: Servicing the Dry-Filter Air Cleaner (Page 1 of 2).



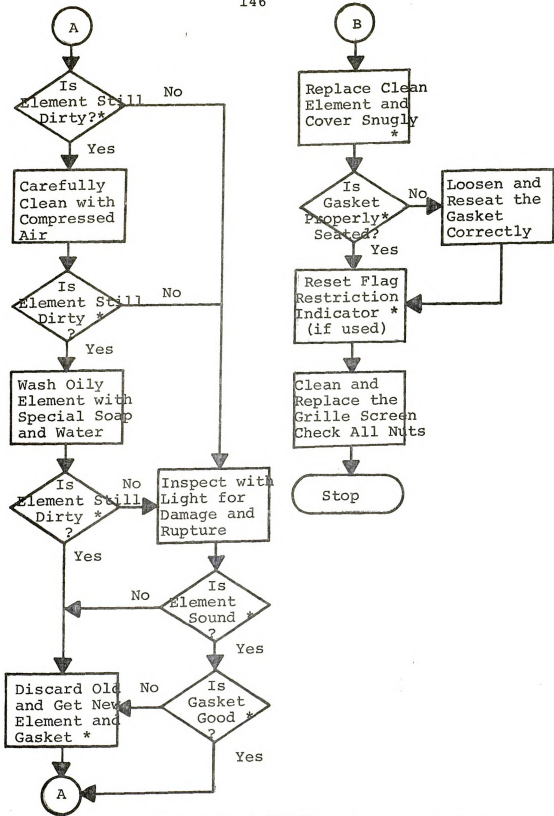
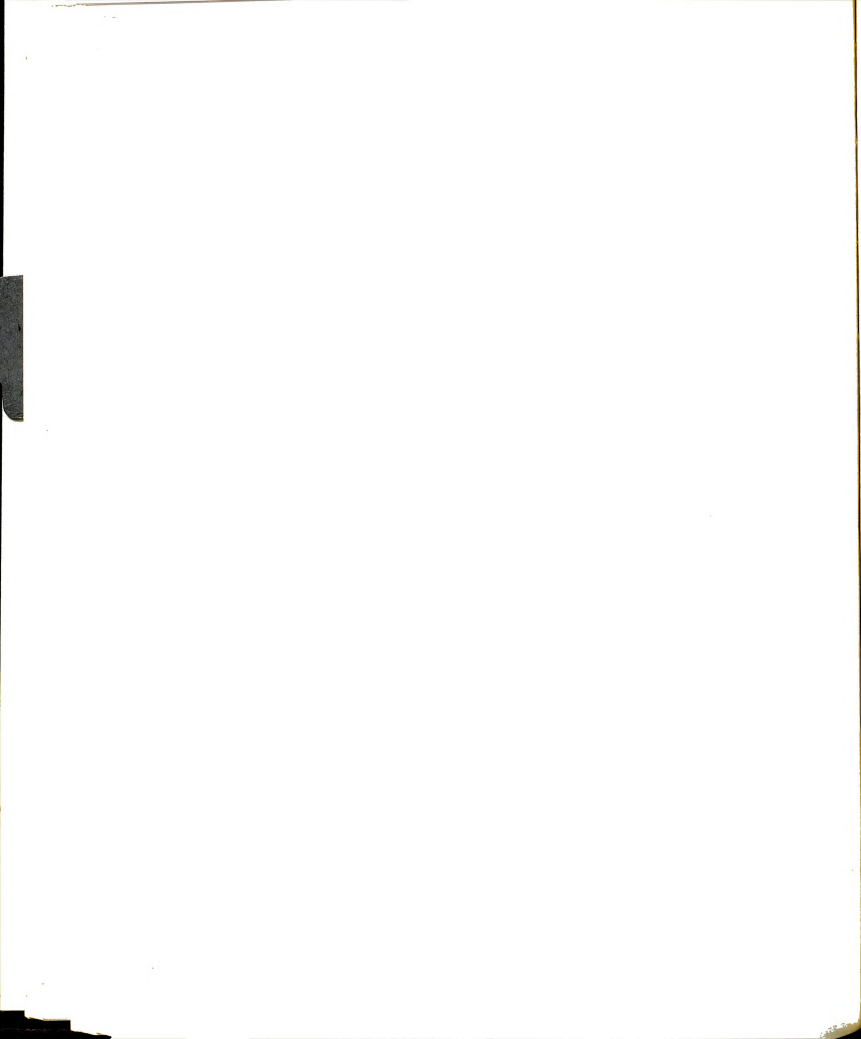


Figure 3.6.--Flow Chart for Lesson B-9: Servicing the Dry-Filter Air Cleaner (Page 2 of 2).

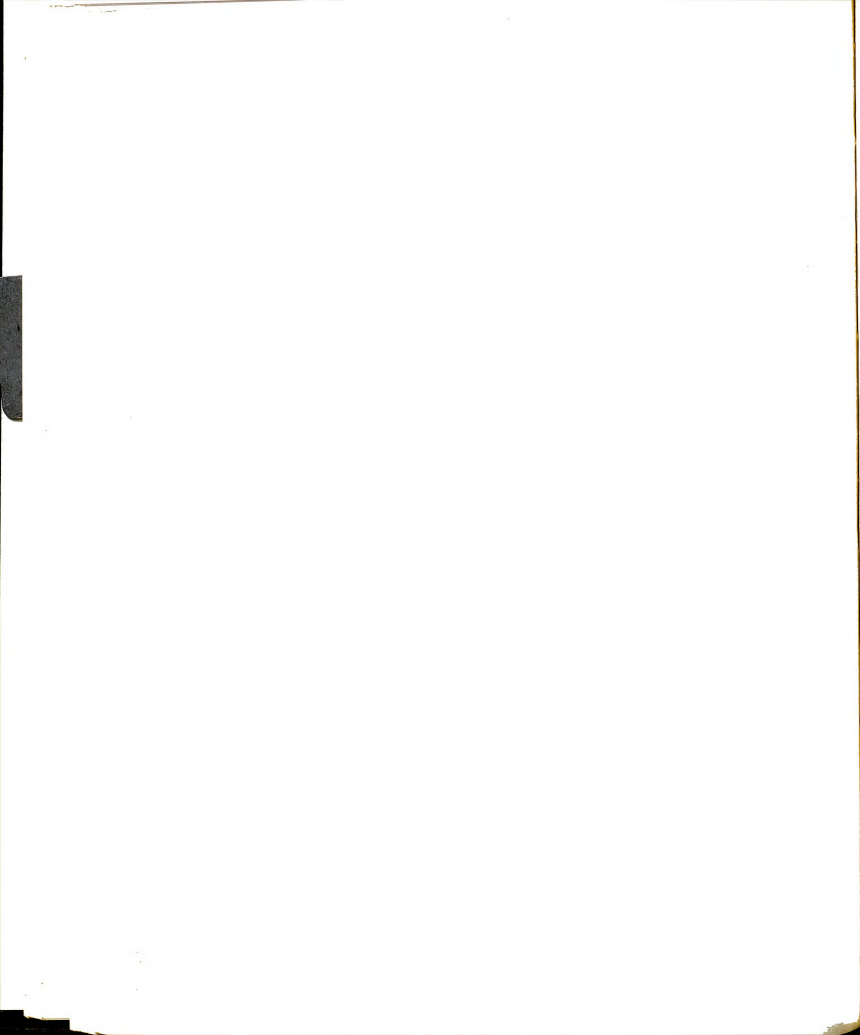


3. As a guide to check each trainee as he performs the skill.

State Lesson Goals in Terms of Behavioral Objectives

The first step in the systems approach to design of instructional systems was to state the learning goals or desired changes in individual response in terms of behavioral objectives. Once this was accomplished, the system designer selected lesson content and provided alternative lessons aimed at attainment of the learning tasks. Alternatives, or a range of graded objectives, gave the instructor flexibility in meeting individual differences in trainees and provided for variations in sophistication, degrees of complexity, length of lesson, depth of coverage, and personal interest to meet the needs of the learners. The behavioral objectives told the instructor exactly what the learner should know, feel, and do at the completion of the training program. For examples of behavioral objectives see sample lesson B-9 on page 163 and lesson D-1 on page 159.

The left-hand column of the lesson plan listed the desired trainee behavioral objectives which are the training goals of the course. Where possible, these changes were stated in terms of well defined measurable behavior expected from the trainees. It was difficult at first to express the teaching changes in terms of



behavior changes that could be measured. With practice it was possible to prepare specific behavioral objectives around which the detailed course of instruction was built. Once the behavioral changes were measurable and clearly defined, it was relatively simple to formulate meaningful questions and evaluation instruments to test training progress and attainment of objectives.

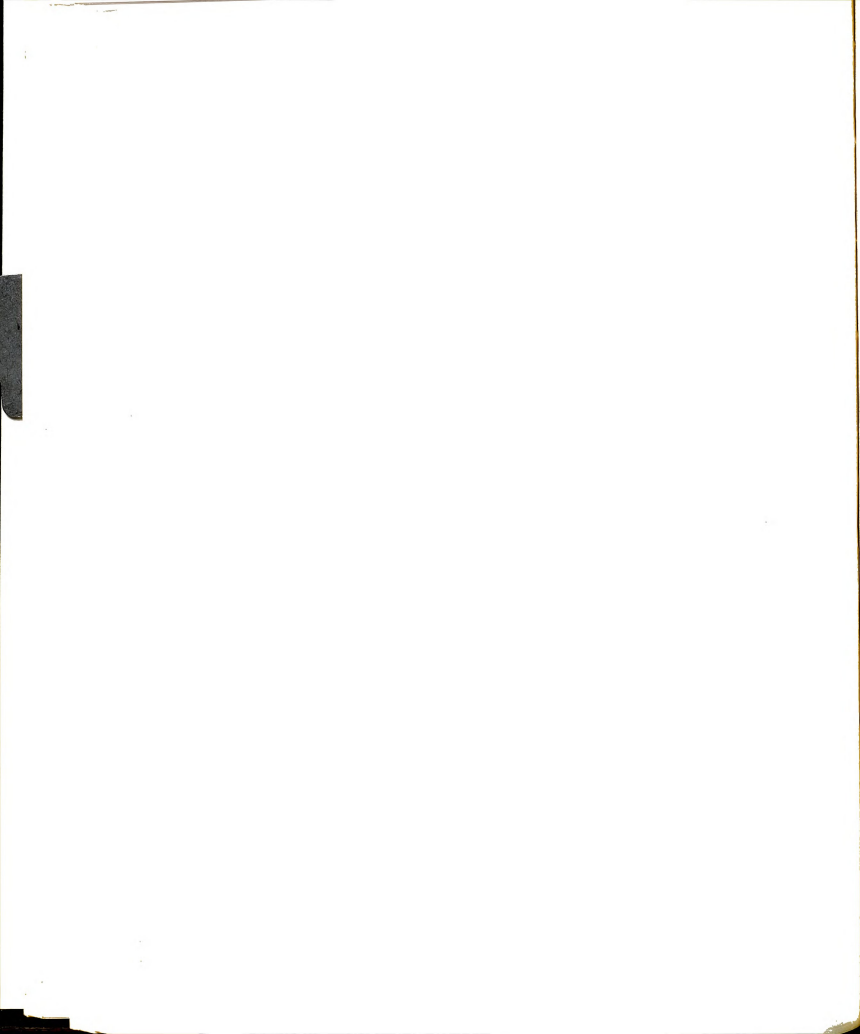
It was important for the instructors to become fully aware of what is expected of the trainee upon completion of each lesson. Therefore, objectives of the lesson were studied carefully before any attempt was made to teach the lesson. These objectives are not to be read to the trainees. They simply form the basis for which each lesson was written

Lesson B-9 has 22 objectives lettered a through u and D-1 has 9 objectives a to i. The first was "to check the dry-type air cleaner weekly." Other lessons may have fewer or even a larger number of objectives. It is imperative that each objective be met. The instructor was cautioned not to overlook any of the objectives stated in the lesson plan.

Evaluate the Behavioral Objectives for Measurability

The training objectives were written in three different forms:

1. First, as statements of desired behavioral change around which the lesson was built.



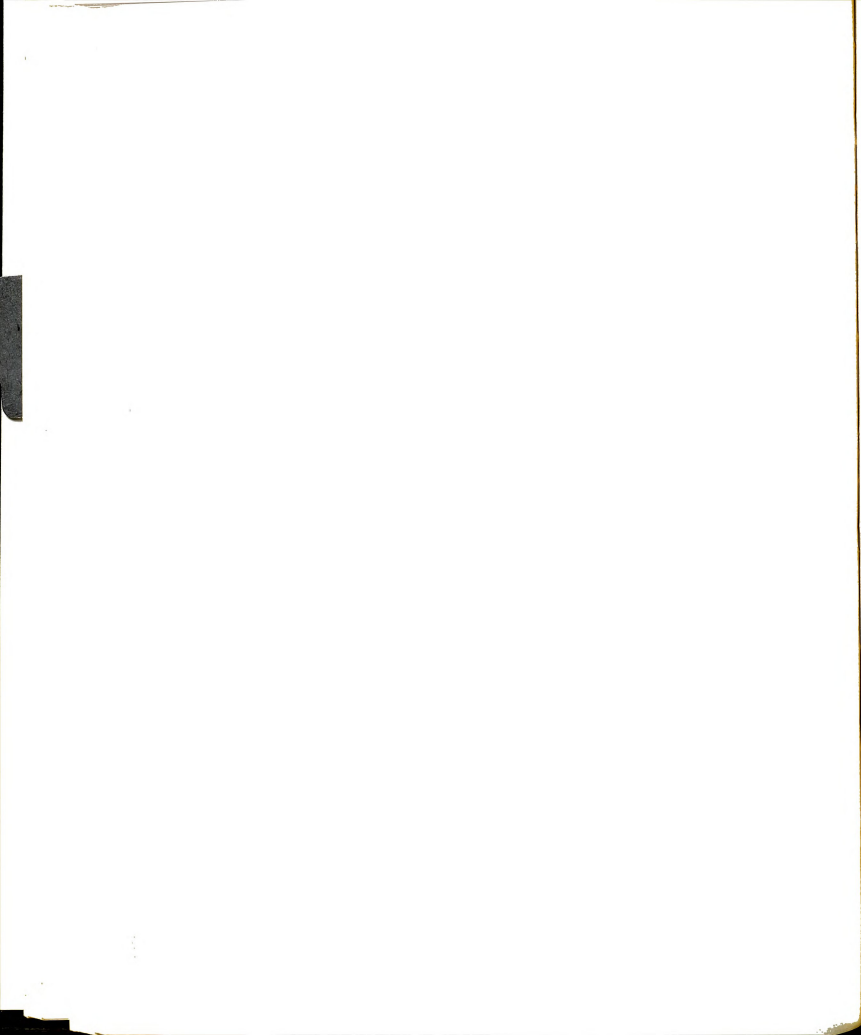
2. Second, as questions for trainees in the pretest or post-test to emphasize the kinds of ideas, attitudes and skills to be stressed.
3. Third, as indicators of student performance in the final evaluation to see if the trainee had learned and was able to perform satisfactorily in a real life situation.

The same behavioral objectives were stressed and evaluated throughout the course in the small group sessions which constituted the major reinforcement through the structured learning and training environment.

In the final evaluation, event number 5 covered the Daily (10-hour) Maintenance Services for a diesel tractor and event number 6 checked the Weekly (50-hour) Maintenance Services. The trainee was asked to perform these services which included servicing the dry-filter type air cleaner. Certain key objectives were selected for the final evaluation performance test. Not every objective was measured in this evaluation but a cross section covered all the important decisions and skills required for a qualified Basic Tractor Operator, Grade I.

See the following chart for the test items used in the final evaluation of the trainee in performing actual service on the dry-filter air cleaner.

These performance checks used in the final evaluation of a Basic Tractor Operator apply only to Event No. 5

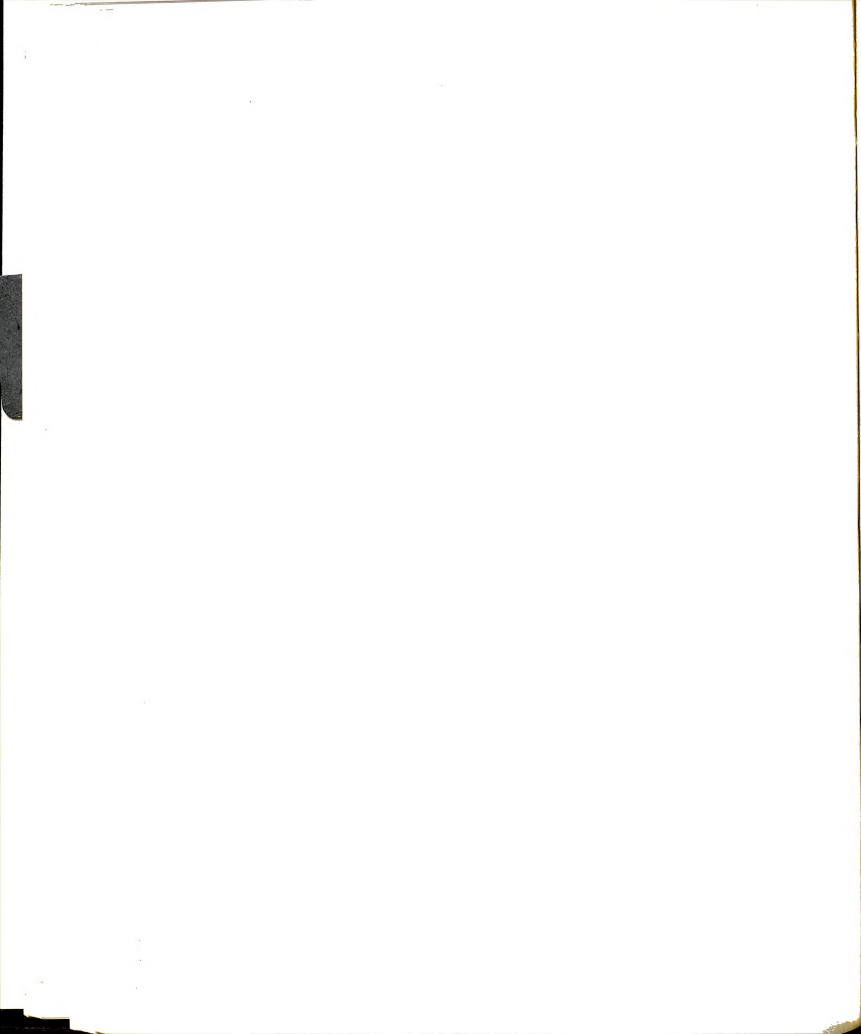


Sample of a Partial Performance Test for Basic Tractor Operators
 Part 9: Servicing the Dry-Filter Air Cleaner (Diesel Engine)
 Event No. 5: The Daily (10 Hr.) Maintenance Services

The Dry-Filter Air Cleaner		(Start Time	Finish Time	) Times Noted	Penalty Factor	Total Points
1.	Failure to check dry air cleaner. (a)			X	50	
2.	Dirt not wiped off filter body before servicing. (c)			X	10	
3.	Pust unloading valve not emptied. (d)			X	10	
4.	Restriction indicator not checked. (b)			X	10	
5.	Incorrect decision made not to service filter. (e,f)			X	20	
6.	Dry element not removed properly or tapped on hand. (g,h)			X	10	
7.	Dry element not checked for damage or cracks. (j,o)			X	10	
8.	Inside of body not wiped out with clean cloth. (p)			X	10	
9.	Dry element replaced incorrectly. (g)			X	10	
10.	Gasket not in place or properly seated. (g)			X	20	
11.	Inner wing nut not tightened securely. (n)			X	10	
12.	Outer wing nut not tightened securely. (n)			X	10	
13.	Restriction indicator not reset. (s)			X	10	
14.	Grille screen not replaced. (u)			X	10	
15.	Excess Time beyond 400 seconds.			X	10	
					sec. X 1/4	
GRAND TOTAL OF POINTS FOR THE TEN DAILY MAINTENANCE SERVICES						

1.	The Air Precleaner					
2.	The Oil-Bath Air Cleaner					
3.	Fuel Sediment Bowls					
4.	Radiator and Cooling System					
5.	Crankcase Oil Level					
6.	Grease the Front Axle					
7.	Tires and Wheels					
8.	Check and Add Fuel					
9.	Dry-Filter Air Cleaner					
10.	Read The Speed-Hour Meter					

Total Raw Score (Negative Points)



on the Daily (10-hour) Maintenance Services for a diesel tractor; Part 9 on servicing the dry-filter air cleaner. (Letters in parentheses refer to the same behavioral objective in the lesson plan.)

Building-In Continuous and Total Evaluation

The continuous evaluation starts before the training program begins, progresses through the lesson presentations and culminates in the final evaluation and certification of the trainees as qualified Basic Tractor Operators' Grade I, II, or III, as appropriate. The evaluation was based on the behavioral objectives the course purports to teach. The instruments and techniques for evaluating the trainees and the BTOC are covered in Chapter IV.

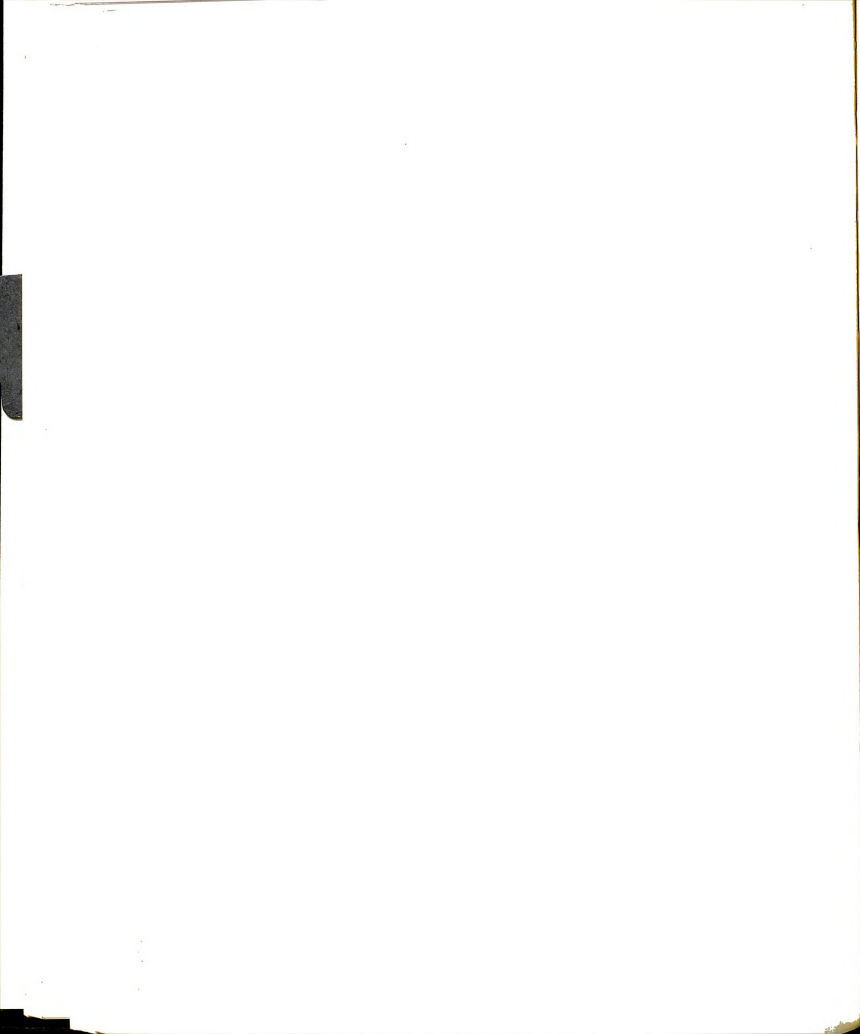
Individualize Instruction for Trainee Involvement and Participation

Establish a Conducive Learning Environment

To insure a properly structured learning and training environment, the following guidelines were suggested for obtaining and equipping the physical facilities to permit individualized instruction.

The training location in a developing country
should be:

- near services of major farm machinery supplier(s).
- within or adjacent to major agricultural area(s).



- easily accessible by a dependable year-round transportation network.
- reasonably close to a College of Agriculture and Departments of Mechanization.
- equipped with inexpensive housing for trainees.

The Training Facilities Should Consist of:

Buildings

- covered building(s) for conference-discussion and laboratory classes.
- a covered open shed to house and store field equipment not in use.
- windows screened against insects and glassed against cold (if required).
- windows to be coverable for movie and slide presentations during daylight.

Utilities

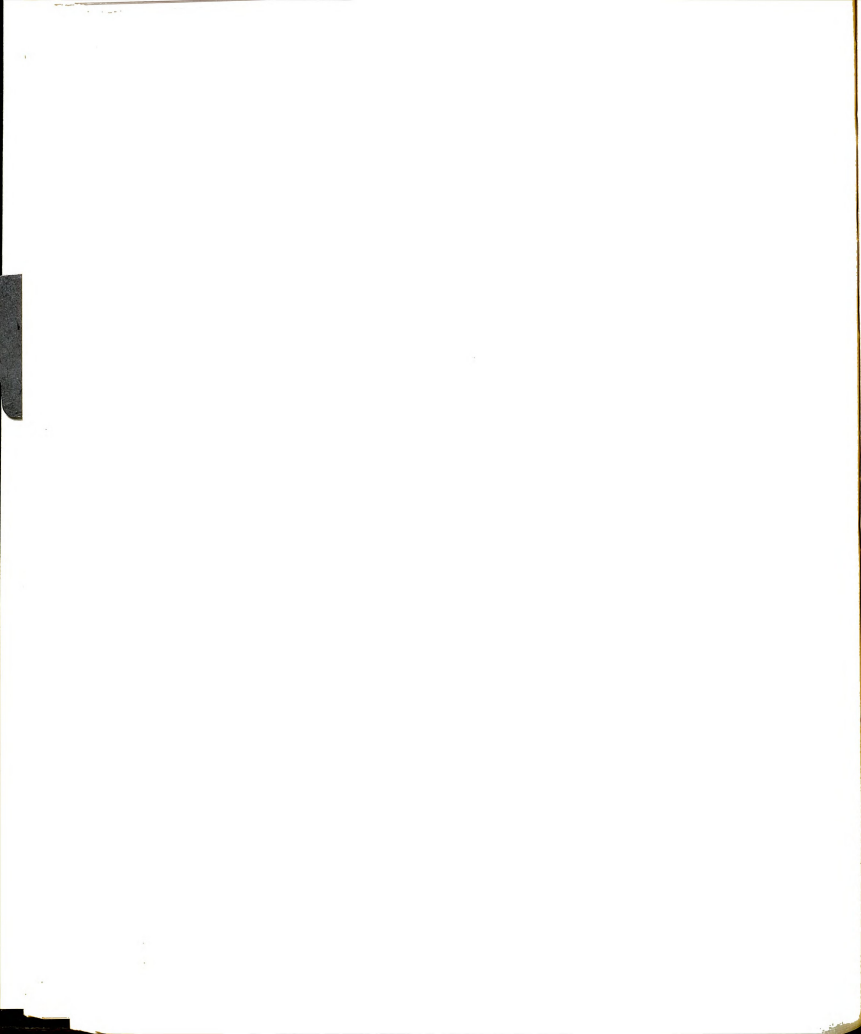
- a heating system for cold climate use (if required).
- a ventilation system for hot weather use and hazardous conditions.
- a lighting system for overcast days and night use.
- electricity for lights and projection equipment.
- water for drinking, washing, and general cleanup.
- toilet facilities equal to average best of area.

Accessories

- chairs with writing arms, or suitable tables and chairs.
- a blackboard or writing wall (substitute a large pad with felt pens & easel or large portable blackboard if it must be moveable).
- a projection screen for slides and movies.
- a box, table or stand for projector.
- wall hooks or easel for holding charts.
- a pointer for charts, blackboard and screen.
- tables or workbenches to display equipment and parts.

Supplies

- chalk, pencils and felt pens for instructor(s).
- paper for writing, washing towels, toilet tissue, etc.
- diesel fuel, oil and grease for practical training and field work.
- suitable containers, funnels, grease rags, cleaning solvent, etc.

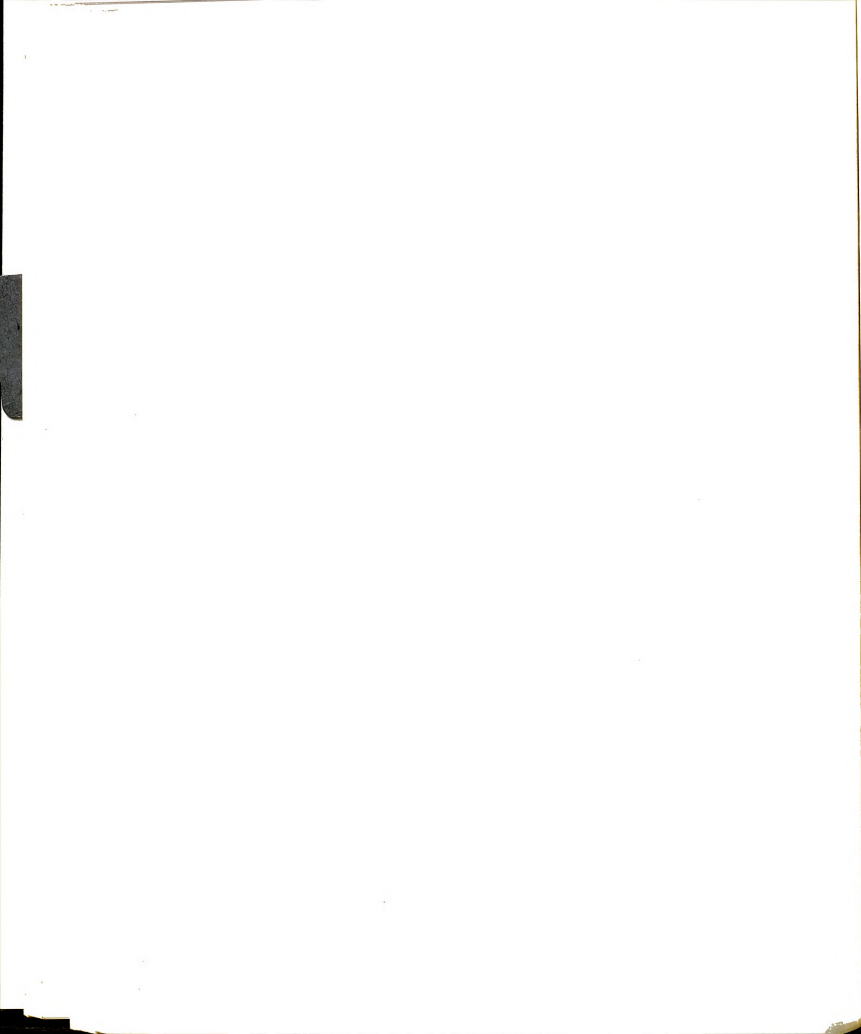


Equipment Available Should Include:

- a minimum of 4 tractors for a class of 20 (ideally prefer 10 tractors for a class of 20 trainees).
- a minimum of the following implements for each two tractors
 - a disk or moldboard plow, integral or semi-mounted
 - a disk harrow or field cultivator, pull type or integral mounted.
- a minimum of the following implements for each four tractors
 - a two-wheel trailer and a four-wheel wagon
 - a rotary mower or other PTO-operated machine
 - such other implements and tools as may be required to meet local needs.
- one set of common hand tools for each tractor, including such items as
 - wrenches, hammer and punches
 - tire gauge, tire pump and valve stem remover
 - grease gun, oil can, and funnel.

Some Concepts for Developing Countries and Manpower Training

To make training meaningful and effective, special consideration must be given to the instruction techniques and the methods used to reach low-education level or cross-cultural trainees. Trainees not previously exposed to formal education cannot learn by simply listening to lectures or by engaging in self-study. They must be carefully led through a definite structured program, shown what to do, actually repeat all demonstrations themselves, be constantly evaluated and finally tested for individual performance. To accomplish these broad goals, the following concepts were formulated to assist in developing the Basic Tractor Operators' Course. These were desirable and



not necessarily actual achievements, depending on how the individual instructor performed.

Type and length of instruction (four 40-hour weeks).

	<u>Hours</u>	<u>Remarks</u>
Conference with show-and-tell demonstrations	26	Emphasize discussion
Laboratory and practical exercises	50	Emphasize practice
Training slides, films, etc.	4	When suitable for interest & variety
Field work and job training	50	Emphasize work training
Examination and testing	30	Measure teaching effectiveness

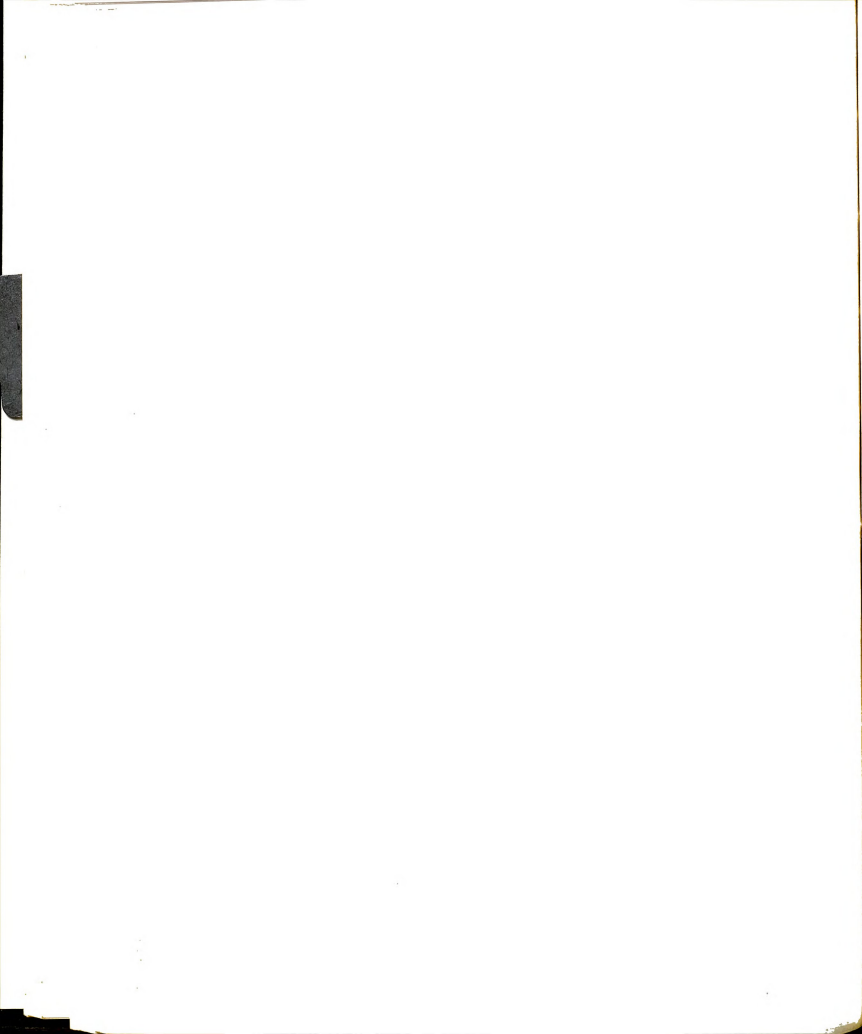
Total hours ± 160

Idealized training day schedule (eight-hour day).

Hour 1	Instructor conference-discussion-demonstration.
Hour 2	Student laboratory and practical exercises.
Hour 3	Instructor conference-discussion-demonstration.
Hour 4	Student laboratory and practical exercises.
Hour 5	Instruction films-discussion-conference.
Hour 6	Student job training and/or field work.
Hour 7	Student job training and/or field work.
Hour 8	Student job training and/or field work.

Length of course.--Mosher (1966, p. 92) makes a

general statement that "a short course [in-service training] that is to include a study of the topic . . . should last at least 11 working days but should probably not be longer than 24 working days." It takes several days for a group of trainees to begin to work well together but no one should be kept away from his normal duties for longer than a month.



Evening classes can be scheduled if time is a limitation and trainees are housed at school.

Basic instructional assumptions.

- Trainees cannot listen to a straight lecture for more than 15 to 30 minutes at one time.
- Conference discussions should be scheduled early in the morning or afternoon.
- Demonstrations, show-and-tell techniques should be interspersed throughout conference-discussions.
- Laboratory and practical work is preferably given in late morning or afternoon when trainees are most apt to be tired.
- Trainees can grasp visual pictures more quickly than word pictures.
- Trainees should become involved in teaching process as much as possible.
- Trainees must be given every opportunity to handle, manipulate and practice with the real object.
- Trainees will learn most from actually doing a job or task, first in small groups and then alone.

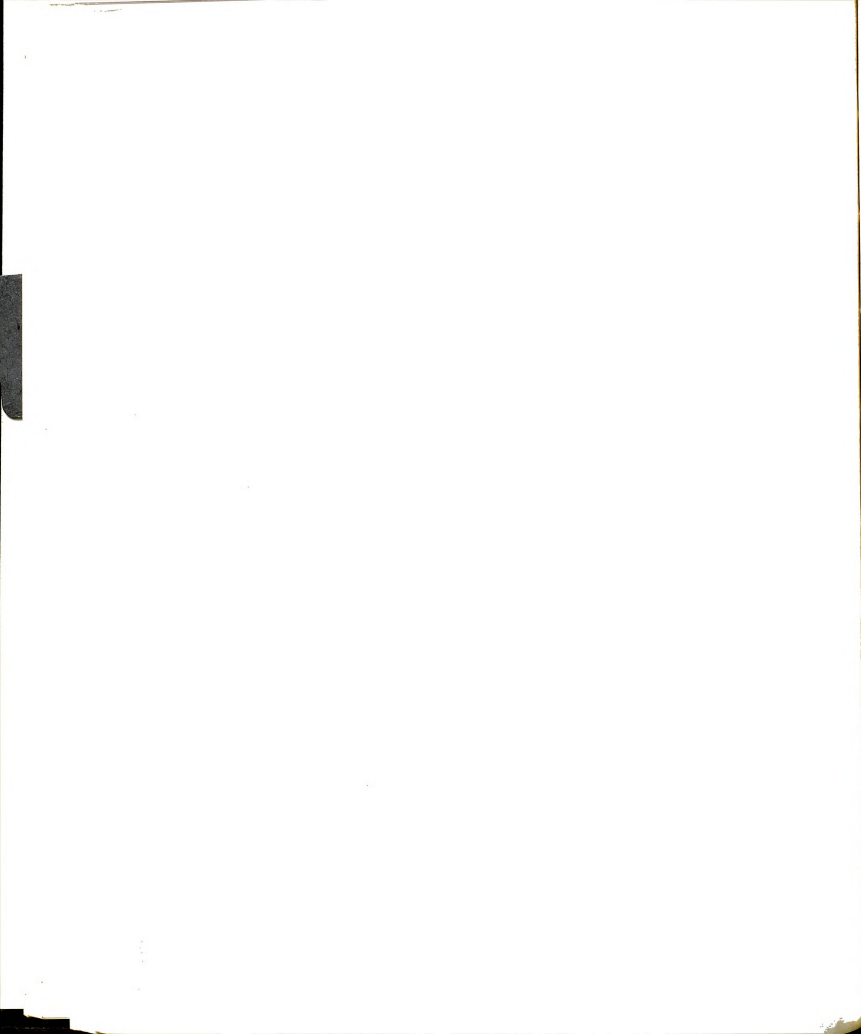
Assumptions about use of instructor's training manual.

- For officials planning, budgeting and supervising agricultural training programs.
- For teaching local instructors in developing countries.
- As a guide for the trained instructor to follow in teaching trainees. (It is not designed for direct use by the trainees.)
- For identifying the key points that tractor operators must know. A simplified short resume in the local language should be prepared to give to the trainee.

Suitable training facilities.--The national or

local government will provide the necessary training facilities or arrange for them in an area suitable for training.

- Building(s) for classroom instruction.
- Sheltered space for laboratory exercises; covered shelter for machinery storage.
- Land for practical training and field work.
Soil should be well drained and preferably sandy or silt loam to permit annual use.



- Area should be large enough to permit each trainee to work at least one hectare (20 trainees = 20 hectares) during each course.
- End use of land should not be critical to permit tillage several times a year.
- One area should be reserved for driver training and obstacle courses.
- It may be possible to do custom work for area farmers for the cost of fuel and oil.
- Dormitory for housing students (resident course).
- Cooking and eating facilities (for permanent center and resident course).

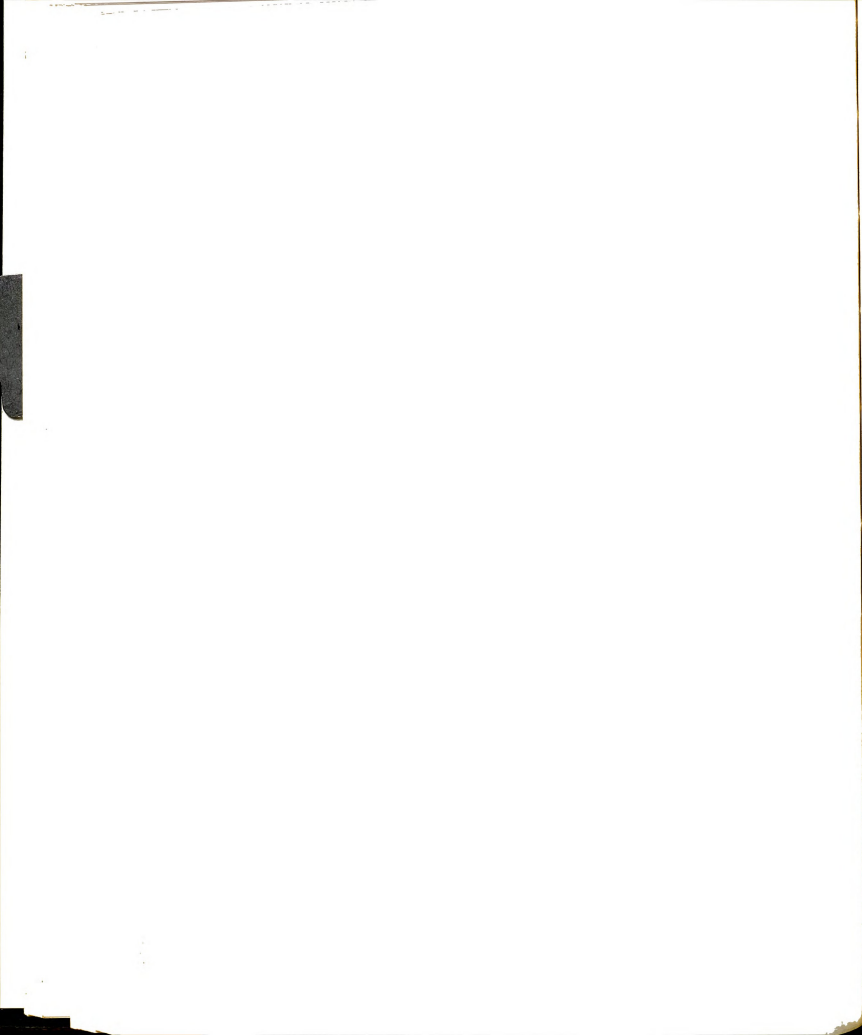
Provision of instructors and assistants.--A training class will be built around a core of 20 students.

- The Basic Instructor staff will consist of two instructors (or one instructor and two assistants).
- Training classes will be given during the off season when possible.
- Local government will provide suitable personnel to be trained as instructors.
- Farm machinery manufacturers will assist the training center in every way possible.

Positive Attitude Reinforcement
(Lesson D-1: Orientation)

Throughout the Basic Tractor Operators' Course special emphasis was placed on developing positive attitudes in the trainees. The first lesson in each major series was designed to set the stage for the development of proper attitudes and good work habits which were repeatedly re-emphasized in subsequent lessons.

As an example, safety is an attitude and a frame of mind that was carefully developed. Just as accidents do not just happen, but are caused, safety does not result unless it is stressed by the instructor. Since actions speak louder than words, the instructor set safety standards



in everything he did. He stressed the affirmative by saying "do this" rather than "do not do that," to emphasize the positive approach.

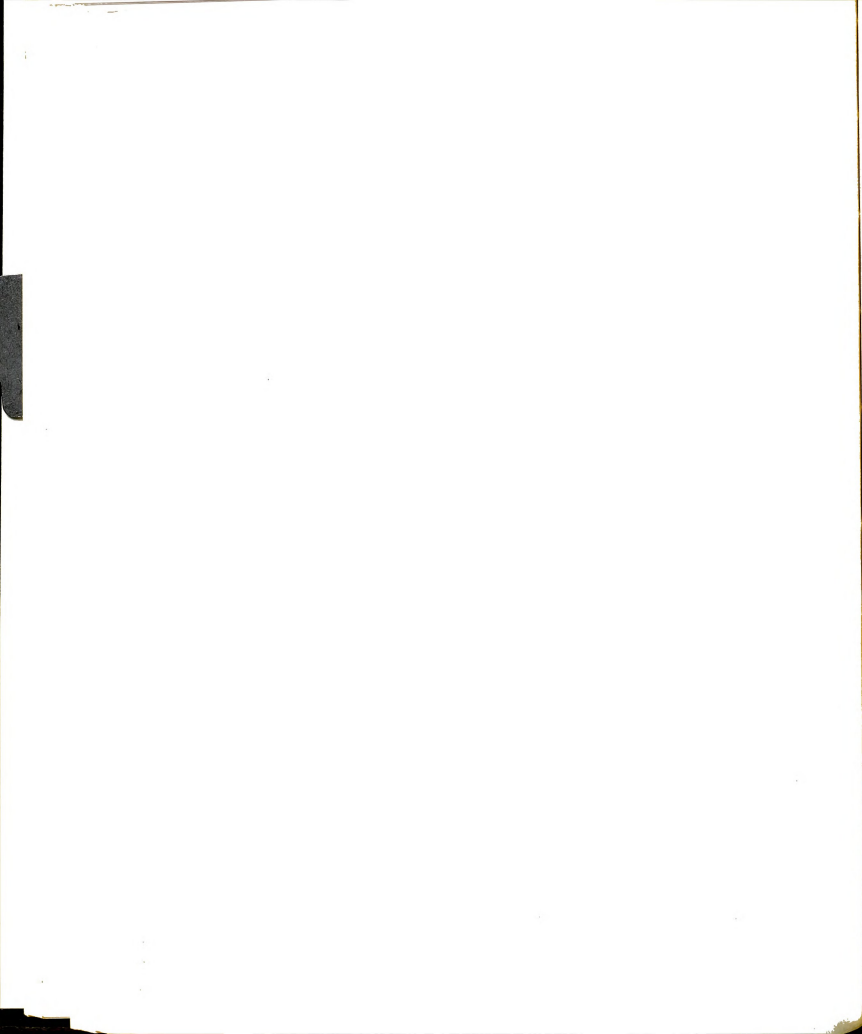
On page 158 the general considerations to be followed in safely operating a tractor are illustrated by Lesson D-1 entitled "General Safety in Controlling the Tractor." The development of a proper attitude was indicated in the behavioral objectives, such as,

1. The tractor operator will develop a safety mindedness.
2. The tractor operator will recognize the need for alertness and proper training.
3. The tractor operator will take proper precautions to warn other people.
4. The tractor operator will not allow other persons to ride on the tractor.

The safety theme was explained in the "Information for the Trainees" and further EMPHASIZED under "Instructional Methods" in the Lesson Plan. Finally, the trainee was asked to show how he would practice safety in operating the tractor during the small group trainee activities and during the field practice.

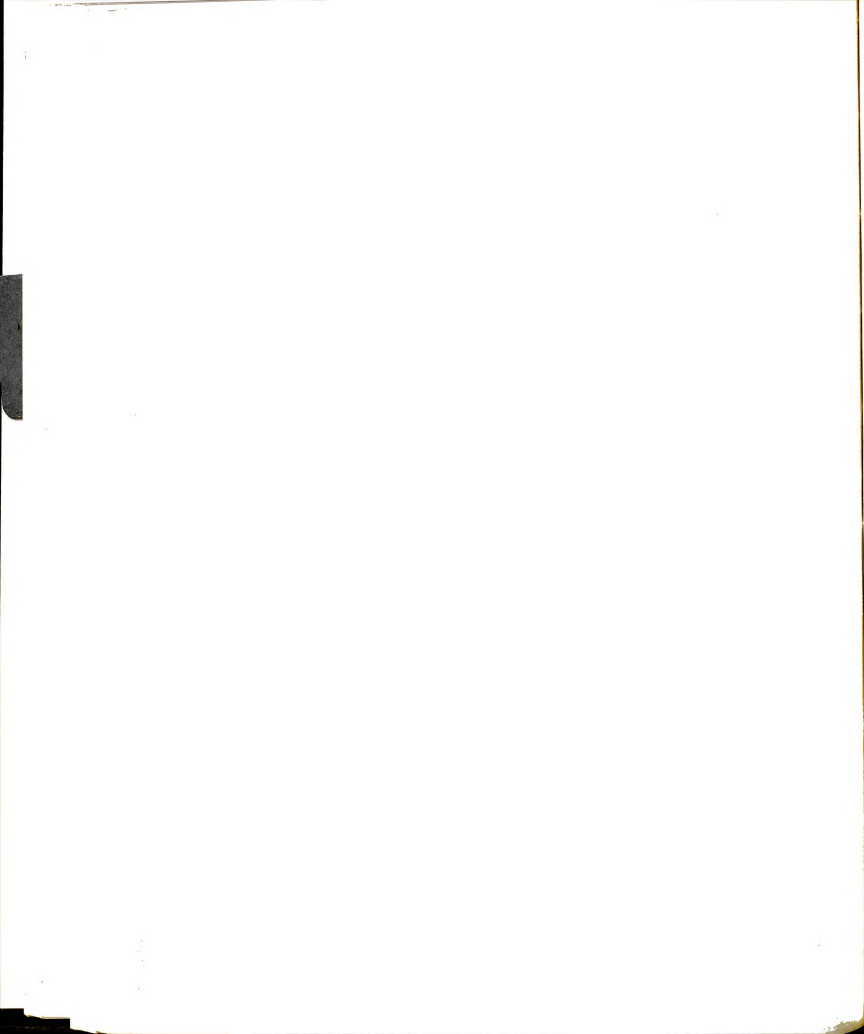
Idealized Instructor/Trainee/Machine Ratios for Training Tractor Operators

Training relationships.--For developing countries and manpower training the following guidelines were developed:



Sample Lesson D-1: GENERAL SAFETY IN CONTROLLING THE TRACTOR
(Page 1 of 6 pages--2 to 6 not included)

Behavioral Objectives	Information for the Trainees	Instructional Methods
The tractor operator will:	In a previous lesson, safety was emphasized while doing the maintenance services and starting the engine. In this lesson driving safety will be stressed. This covers all aspects of safety during maneuver and operation of the tractor in the field, on the road and around the farmstead.	EMPHASIZE safety is an operator's business.
a. develop a safety mindedness.		
b. recognize need for alertness and proper training.		EMPHASIZE training and alertness.
c. take proper precautions to warn and watch out for other people.	The modern tractor is a powerful and dangerous machine. In the hands of an inexperienced or careless operator it can cause great damage or injury to property and people. The operator must be trained to handle the tractor safely at all times and he must be alert to prevent accidents. Safety can be considered from viewpoints of starting, driving, stopping and stationary power use. Before starting to move the tractor the operator must check to see that everything is ready to go. The operator's first concern is other people who might be affected by movement or use of the tractor. The	
		In developing countries operators must be especially careful of children and curious bystanders.



1. For one qualified instructor with or without assistants:

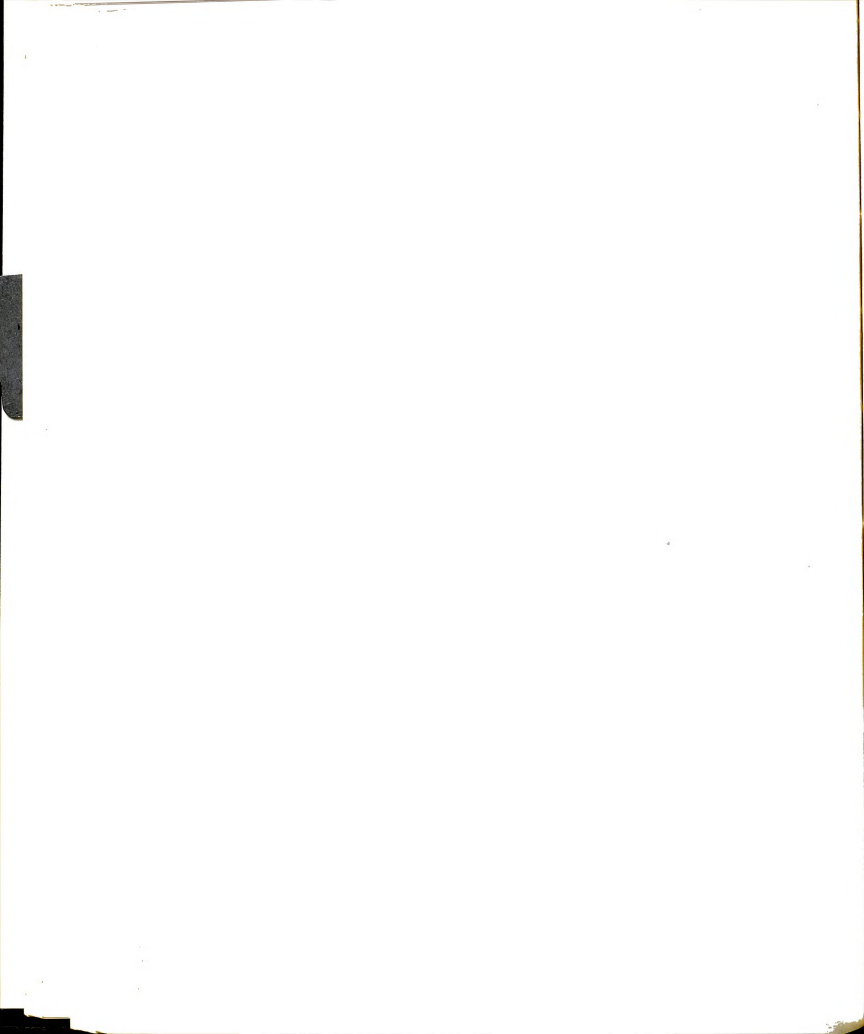
- The ideal instructor/trainee ratio is 1:4 up to 1:6.
- The maximum number of trainees one instructor can handle effectively is 10 (up to 30 for large group instruction).
- Assistant instructors or group leaders can be used to work with small groups of trainees (up to a maximum of six) under direct supervision of a qualified instructor.
- One instructor and one assistant instructor can handle small group instruction for a maximum of 16 trainees, but preferably only 12; with two assistant instructors the maximum class size is 22 with 18 preferred; and with three assistants the maximum size class is 28 with 24 preferred.
- For show-and-tell demonstration teaching techniques, the need for large, expensive equipment can be minimized by using individual parts, cutaways, models, drawings and charts.

2. With two or more instructors without or with assistants:

- Ideal instructor/trainee ratio is still 1:4 to 1:6.
- Trainees can be divided into separate groups to be taught different subjects by different instructors.
- Different subjects can be scheduled concurrently and class groups rotated to utilize scarce facilities or equipment more effectively.
- The need for student practice equipment can be reduced if one of the concurrently taught subjects does not require the scarce machine in its presentation.
- Assistant instructors for each additional 4 to 6 trainees can be used to enlarge the class size and still retain individualized teaching if sufficient training material is available.

3. Size of group.--Mosher (1962, pp. 87-88) says

"Even in a discussion group about 30 trainees is the maximum number for good results. . . . Normally each class should include 15 trainees. The best number is probably between 20 and 25."



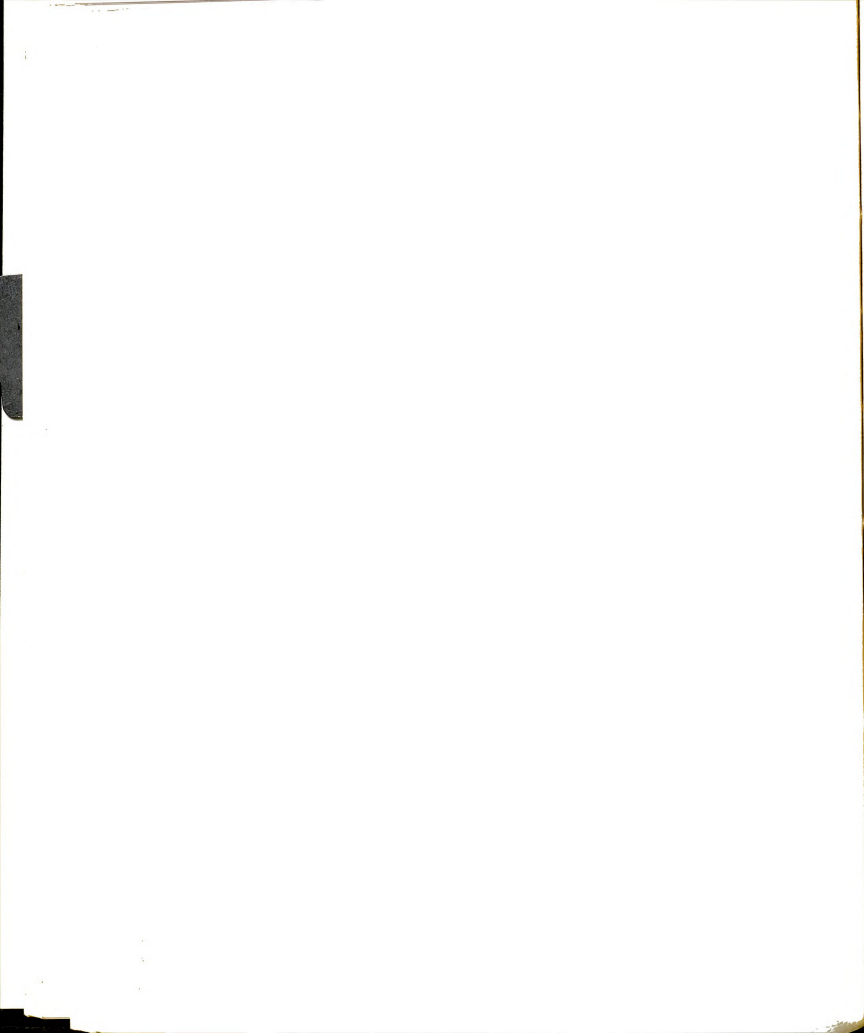
Equipment requirements.--Adequate individualized instruction was based on these guidelines:

1. The ideal tractor/trainee ratio is 1:2.
 - The maximum tractor/trainee ratio for classroom or laboratory use is 1:6.
 - The maximum tractor/trainee ratio for practical exercises and field training is 1:4.
2. The preferred arrangement for equipment is:
 - Ideally each trainee should bring his own tractor to the training center.
 - Trainees without tractors can be assigned to work with a trainee who has a tractor or with school tractors.
 - Each training center shall be equipped with at least two regularly assigned school tractors that can be used for practical field work and on-the-job training.
 - Each school tractor shall be equipped with all necessary attachments, implements and tools used in the training program.
 - Tractors brought in by trainees should be checked and any missing implements and tools furnished by the school.

Large Group Instruction (Lesson B-9: Servicing the Dry-Filter Air Cleaner)

The instructional program for each element is briefly described below for a typical lesson in the Basic Tractor Operators' Course.

Large group activities.--The head instructor is responsible for making the large group presentations. The lesson material for these discussions was given in the general lesson plan under the heading "Information for Trainees." This material was used as a guide by the instructor. It was not intended to be read to the trainees. The



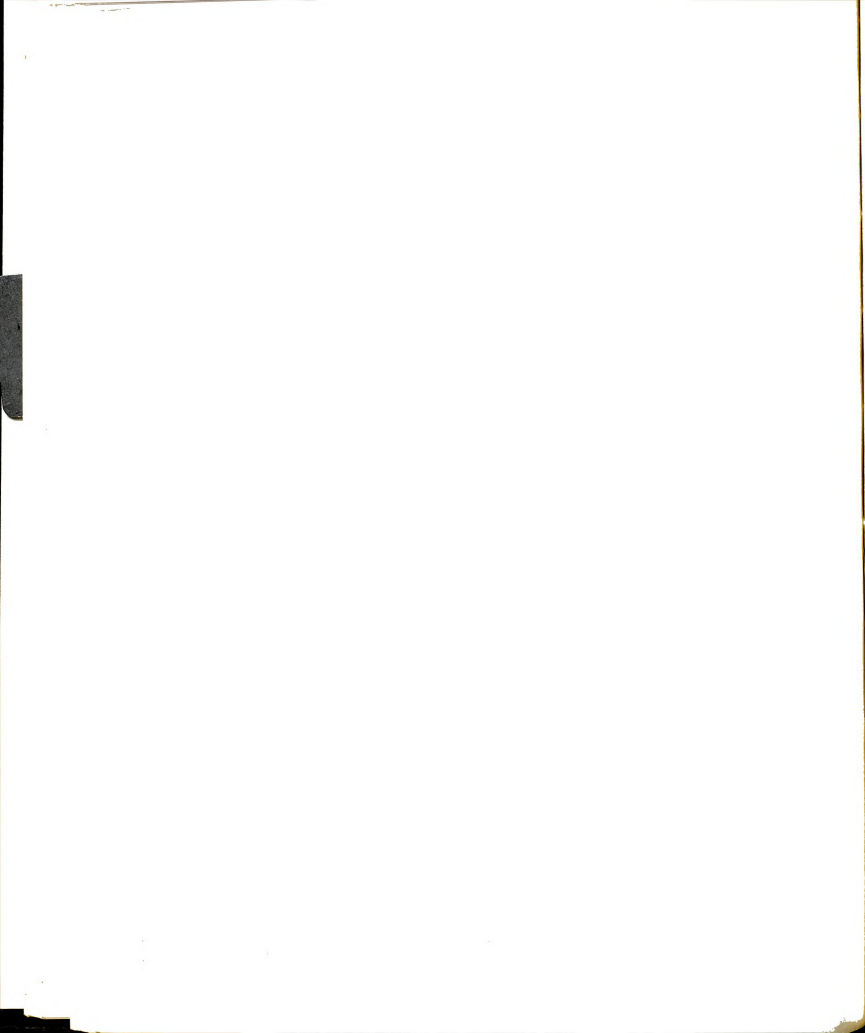
instructor chose only that information needed by the trainees to qualify them for the job of Basic Tractor Operator, Grade I. If the trainees were completely ignorant, most of it was covered, but if they had some experience only certain parts were used.

The main presentations were made as interesting as possible by utilizing demonstrations and teaching aids to secure and retain the attention of even the most indifferent trainee. The recommended training method was conference-discussion-demonstration to secure trainee involvement (Figure 3.9).

Behavioral objectives.--They are already discussed on pages 148 and 149 and examples are given in sample lessons B-9 and D-1, illustrated on pages 162 and 158, respectively.

Information for trainees.--The center column of the lesson plan was devoted to "Information for the Trainees." This information was provided for the instructor to stimulate discussions with the trainees. The lecture method bored the trainees and they quickly lost interest. By asking key questions maximum use was made of the large group session to increase the learning effectiveness.

Slides, charts, models, and demonstrations of principles and skills were used to add spice and variety to the conference discussions. All trainees responded to this method once they felt the instructor was talking



Sample Lesson B-9: SERVICING THE DRY-FILTER AIR CLEANER
(Page 1 of 3 pages--2 and 3 not included)

Behavioral Objectives

The operator will:

- a. check the dry-type air cleaner weekly
- b. remove the left grille screen to check the air cleaner restriction indicator.

Information for Students

If the tractor is equipped with a dry-type air cleaner the operator should inspect it every 50 hours or weekly. To inspect the air cleaner restriction indicator remove the left grille screen.

- c. clean the element if the red indicator hand is showing on a tractor equipped with a restriction indicator.

A portion of the red signal may be visible at times during operation. This is normal. However, if the red indicator is locked in place and is fully showing it is an indication that the element inside the air cleaner should be cleaned.

- d. inspect the unloading valve for clogging.

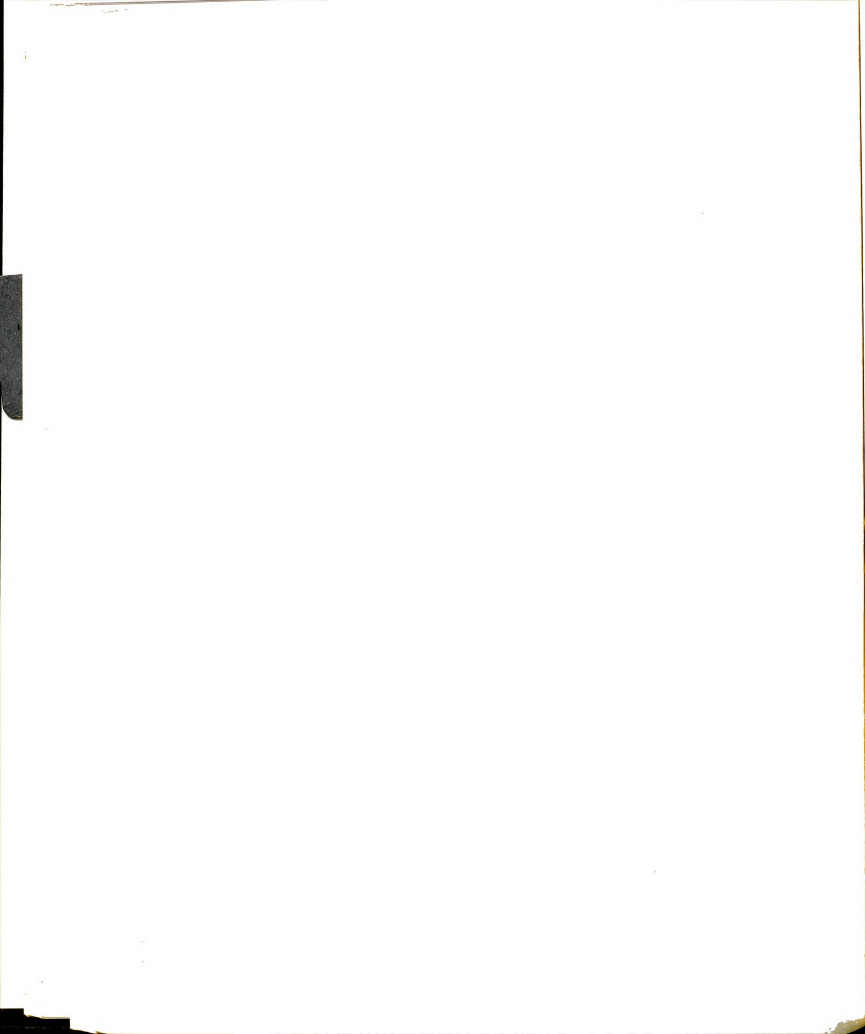
If the tractor is not equipped with a restriction indicator the operator should remove the right grille screen and inspect the dust unloading valve under

Teaching Methods

Demonstrate removal of screen or have a student demonstrate if previously covered.

Point to the restriction indicator (if tractor is so equipped).
Before class, hold hand over air intake with the tractor running to make the red indicator come on. Let the students see the indicator with the red showing (or use a diagram).

Demonstrate.
Show example of element that needs cleaning.

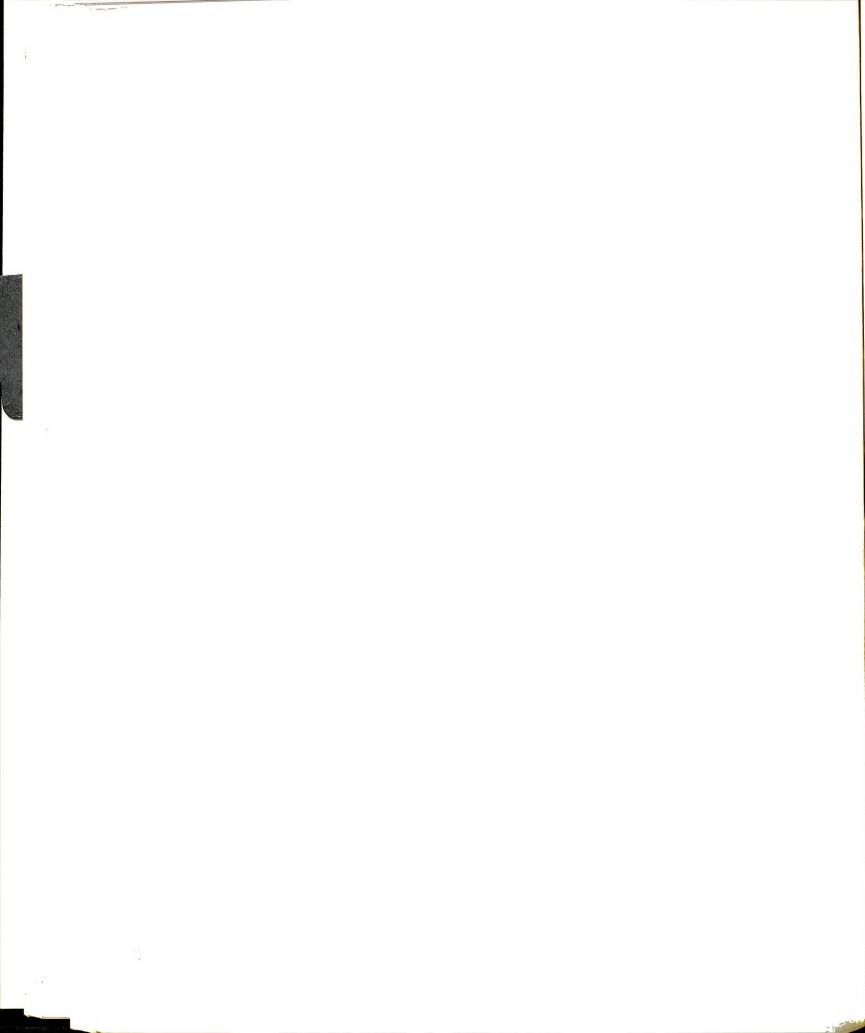


directly to them. The instructor carefully prepared his presentation and made notes to relate, improve or delete portions as required. All demonstrations were rehearsed ahead of time and assistant instructors or group leaders helped in conducting the demonstrations. Drawings and charts were reviewed before class to make sure they were clear and pertinent to the course objectives.

Instructional methods.---The right hand column of the lesson plan suggested methods for the instructor to achieve lesson objectives. The selection of the teaching method depended primarily upon the trainee's background and the degree of participation (Figure 3.7).

When a point needed emphasis, special care was taken to make sure the trainees understood the material. This was done by raising the voice, repeating and reviewing the point or writing it on the chalk board, etc., depending on the facilities, trainees and cultural factors. Instructors used imagination and ingenuity to find new and interesting ways to help the trainees learn the material.

Slides were used to help reinforce the learning process. Instructors used teaching aids and practical exercises whenever possible to clarify or reinforce a point since trainees learned faster when they used their eyes and hands as well as their hearing. See Figure 3.8 on the type of instruction recommended for different training levels.



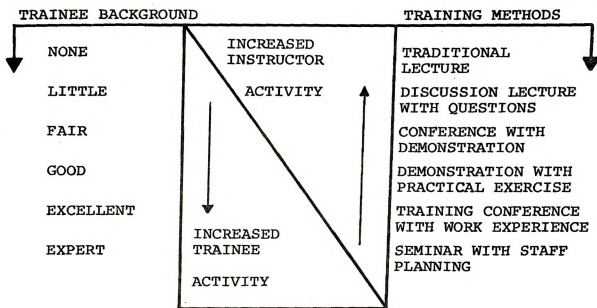


Figure 3.7.--Selection of Training Method Based on Trainee's Background.

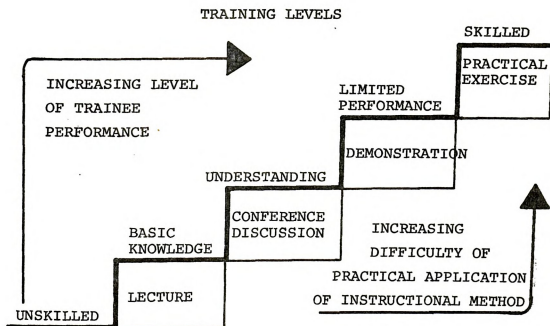
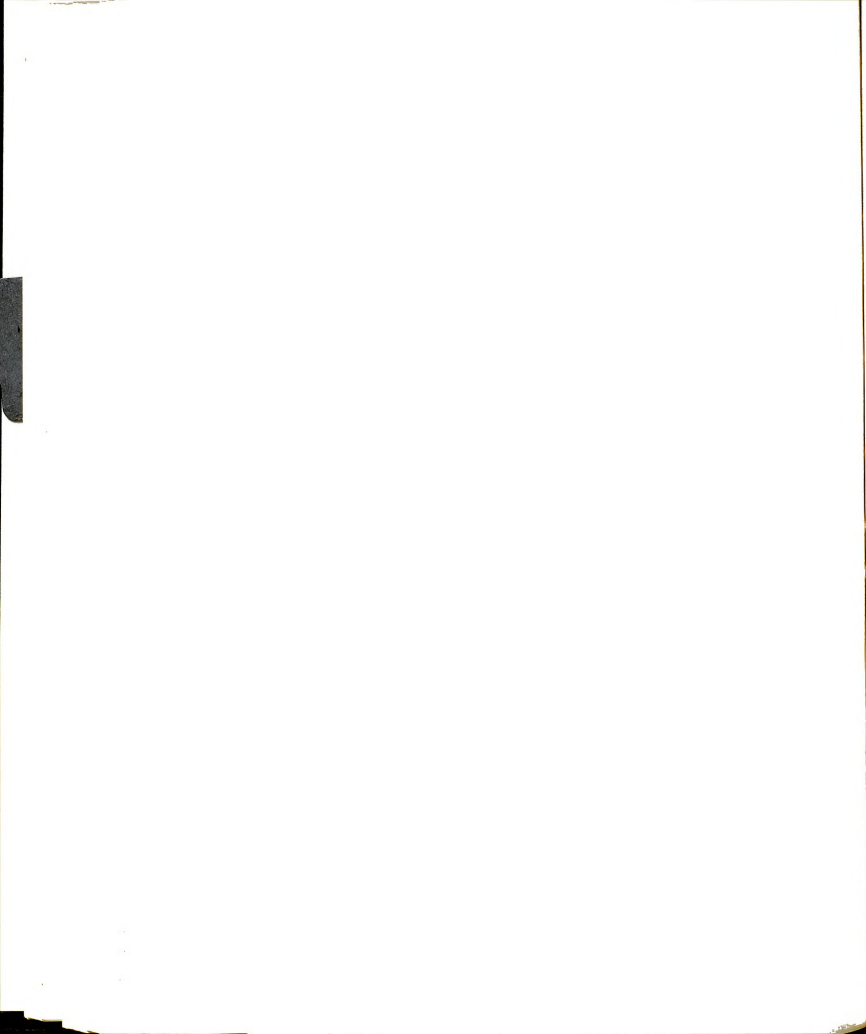


Figure 3.8.--Training Levels Achieved with Various Methods of Instruction.



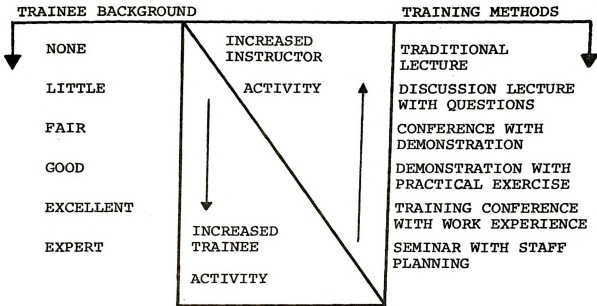


Figure 3.7.--Selection of Training Method Based on Trainee's Background.

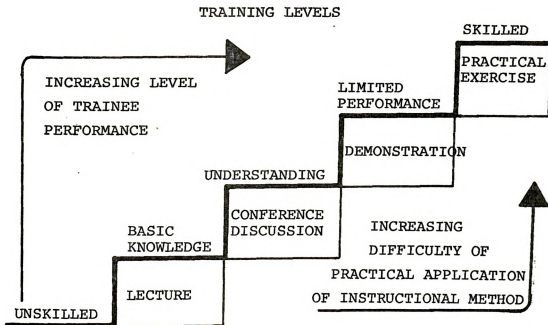
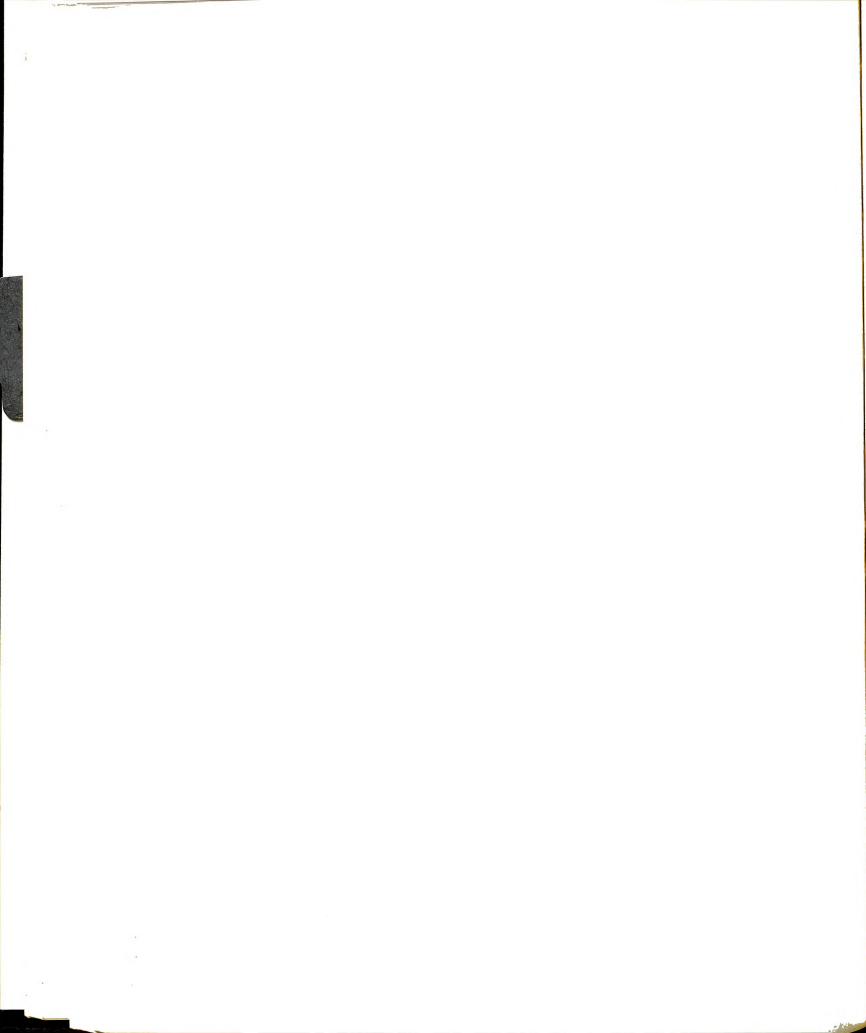


Figure 3.8.--Training Levels Achieved with Various Methods of Instruction.



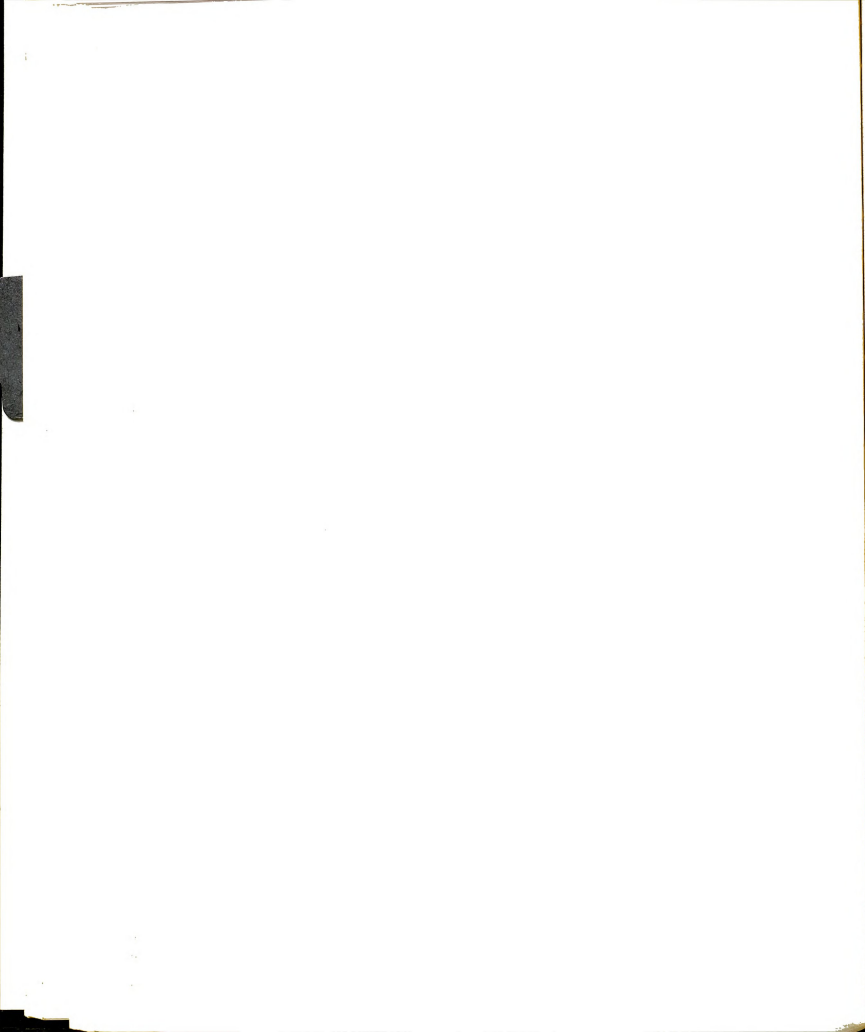
Mosher (1962, p. 99) states that

In preparing for each session, keep in mind that the primary purpose of . . . preparation is to plan the session to secure maximum participation by the trainees. They will learn only as they participate. . . . They will learn very little as passive listeners (or non-listeners) to materials presented orally by the trainer. A secondary objective is to plan for a varied presentation of each topic.

The type of worker desired determines the teaching method to be employed. For example, if only unskilled workers are needed, the lecture method will suffice. But if a skilled workman is to be trained, the most informative and personalized instruction must be used such as the conference, demonstration, and practical exercise. See Figure 3.8 for the training level achieved by different types of instruction.

Small Group Participation (Lesson B-9:
Trainee Activities)

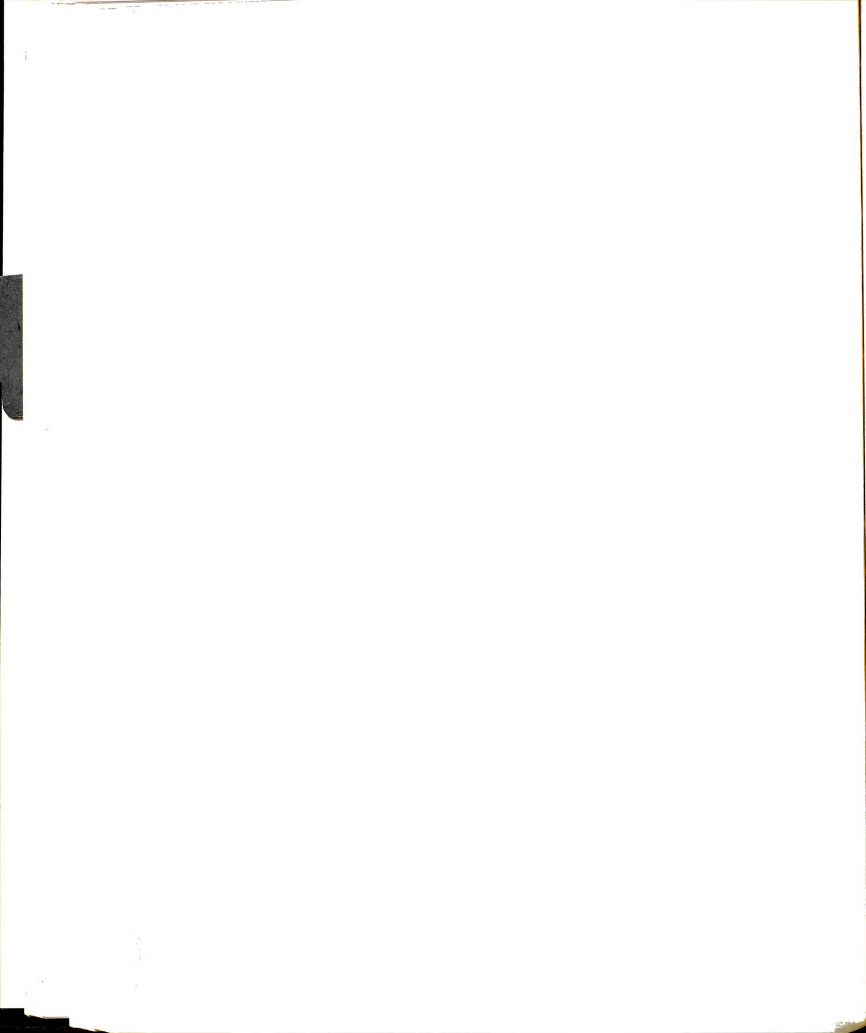
Except for the introductory lessons, a trainee activity sheet was included with all lessons in the Basic Tractor Operators' Course. (See page 169.) These forms were designed for instructors and assistants as a guide in conducting small group sessions. One instructor or assistant cannot effectively train more than four or five trainees at a time in these sessions. The activity sheets were developed in conjunction with the "daily trainee evaluation forms." Used with the evaluation forms they provided a simple and accurate method of recording trainee progress and competency for each lesson.



Preconditions.--The first column on the activity sheets listed the preconditions that were arranged before class. In some cases these preparations simply called for having a tractor available. Other times more elaborate preparations were needed, such as draining oil from the crankcase so the trainee would find a low oil level when he made the daily maintenance check. It was important to set up the conditions before the trainees arrived for class.

Instructions to trainees.--The "instructions to trainees" were either in the form of questions or directions. It was necessary for the full meaning of every instruction to be clear to the trainee, since his response depended upon his perception of the question. All material asked had been previously covered by the instructor. Each trainee in the group responded to several questions in the lesson and the questioning continued until the correct response was attained. Trainees were not belittled for an incorrect response, but were encouraged by giving them questions which they could get right from time to time. If none of the trainees responded correctly, the instructor used the opportunity to reteach the material.

Questions were very effective when properly used. Questions improved the discussion by (1) increasing interest, (2) stimulating thinking, (3) fitting the instruction to the class, (4) bringing out student experiences,



- (5) providing drill, (6) emphasizing main points, and
- (7) testing effectiveness of training.

One way to develop thought-provoking questions is:

1. State the fact to be taught--extra riders are not allowed on the tractor.
2. Change the statement into a direct question--are extra riders allowed on the tractor?
3. Reword the question so it can be discussed--why are extra riders not allowed on the tractor?

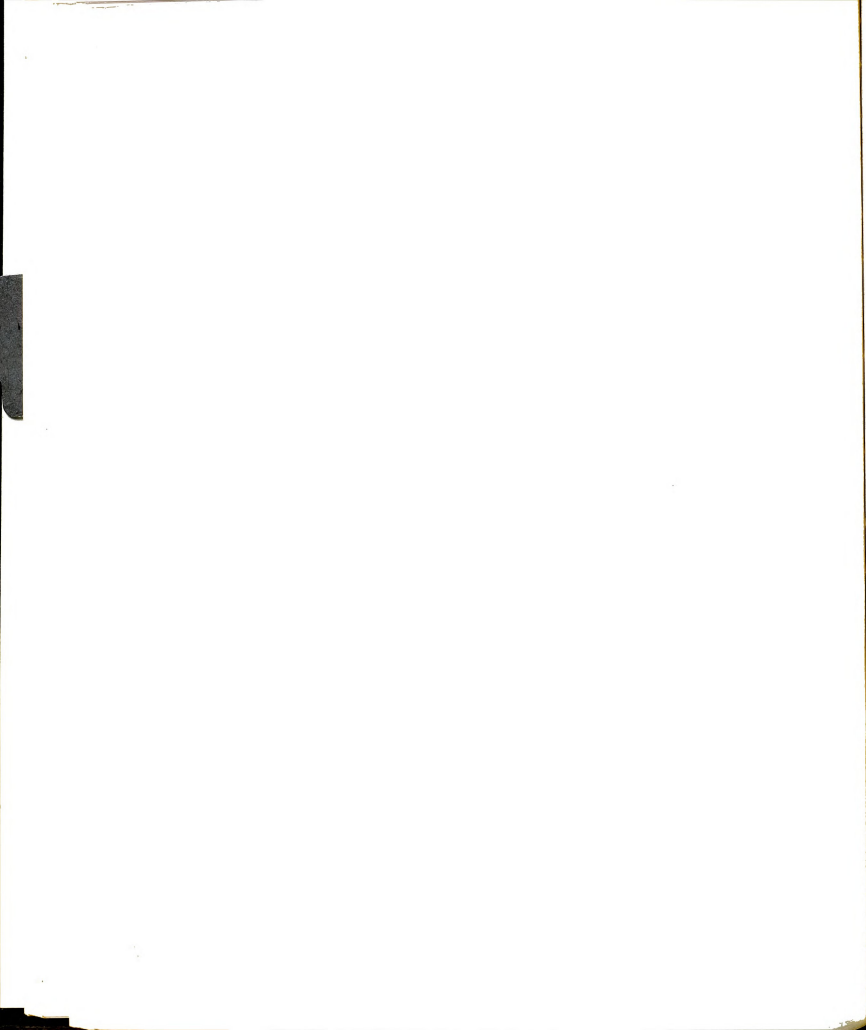
Checklist for instructors.--The checklist was

designed as a series of numbered responses to help the instructor determine if the trainees responded correctly to the instructions given. As the trainee answered, the number of the response question was placed in the appropriate column on the Trainee Daily Evaluation Form (Figure 3.9).

For example: If the first trainee answered correctly to item one, the number "1" was placed in the "correct" column. If the second trainee missed the next question, "2", but the third trainee got the same item correct, a "2" was placed in the "incorrect" column for trainee number two and a "2" also in the "correct" column for trainee three. Questioning was continued until all items were answered correctly.

The daily rating of attitudes, skills, and knowledge will be covered under Evaluation in Chapter IV.

Each lesson covered specific objectives and the instructions to the trainees were designed to determine



Form EV-2		TRAINEE DAILY TRAINING EVALUATION			
Instructor <u>Bolton</u>					
Date <u>May 1</u> Group <u>D</u>					
		Daily Rating#			Key(*) Checkpoints
Name of Trainee	A	S	K	Correct	Incorrect
Number B-9					
Lesson: <u>Dry Air Cleaner</u>					
1. Jose	0	1	2	1	
2. Juon	+	2	2		2
3. Roberto	+	3	3	2	
4. Validiz	-	2	2		

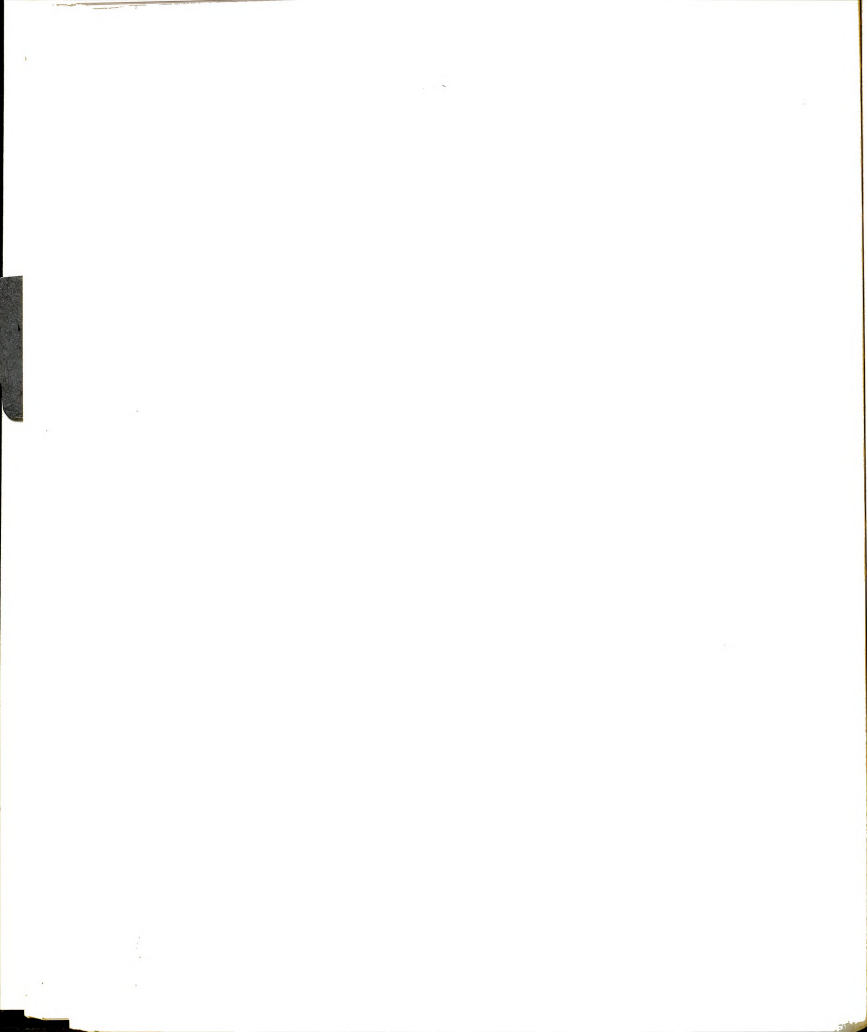
Figure 3.9.--Sample Procedure for Filling Out a Trainee Daily Evaluation Form for the Basic Tractor Operators' Course.

if the trainee had achieved these objectives. The student responses were divided into:

1. Essential material indicated by an "*";
2. Desirable but not critical information or skills to meet the minimum requirements.

The trainee was expected to know and perform all of the starred (*) items to meet the minimum standard established for a "qualified" Basic Tractor Operator, Grade I. If the trainee mastered all objectives he would receive a higher rating.

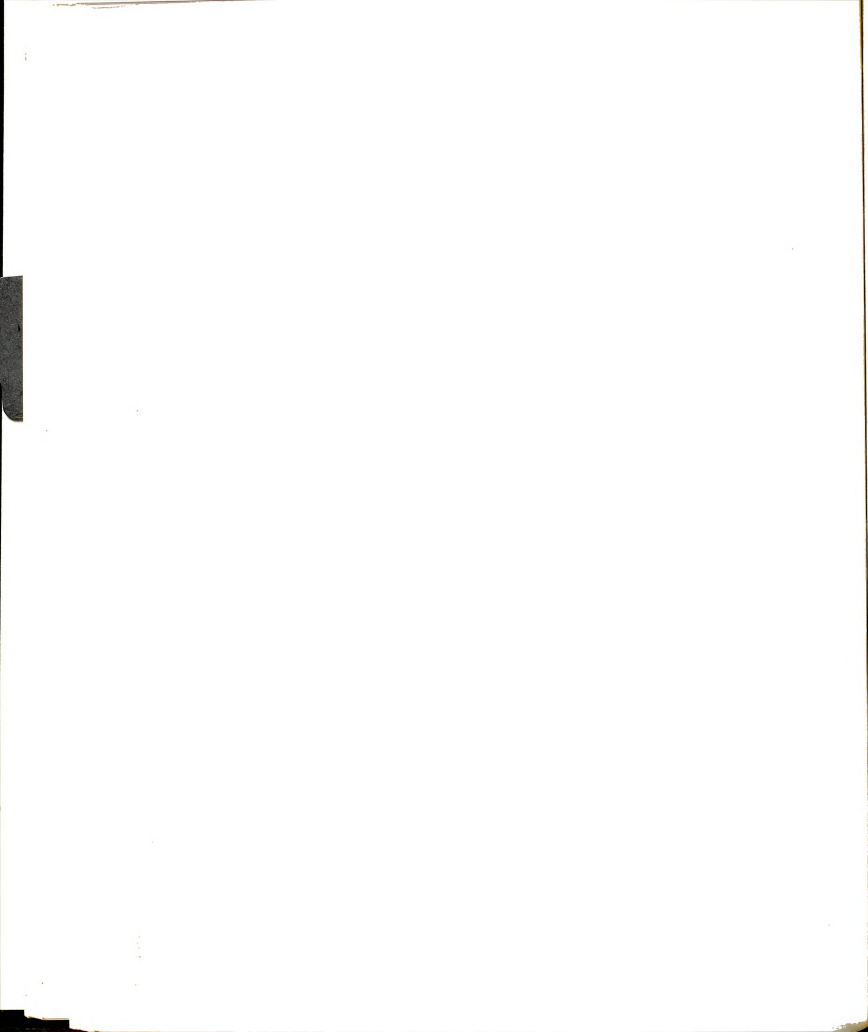
Instructional aids.--The right hand column of this sheet was devoted to a list of instructional aids which could be used with each small group session. As many of



Trainee Activities for Lesson B-9: SERVICING THE DRY-FILTER AIR CLEANER
(Page 1 of 2--2 not included)

<u>Preconditions</u>	<u>Instructions to Trainees</u>	<u>Checklist</u>	<u>Instructional Aids</u>
Tractor smoking badly while running with dry-filter type air cleaner.	WHAT WOULD YOU DO IF THIS HAPPENED TO YOUR TRACTOR?	1.*respond that he would check the air cleaner?	With rag or hand block passage to air cleaner to make engine smoke.
	LOCATE THE AIR CLEANER.	2.*remove the left grille screen and point to the air cleaner?	Clean cloth
Set restriction indicator to show red warning flag.	WHAT TYPE OF AIR CLEANER IS IT?	3.answer correctly?(dry filter type)	Dirty filter no longer serviceable
	DOES IT HAVE A RESTRICTION INDICATOR?	4.remove right grille screen and check?	Compressed air
	POINT TO THE INDICATOR (IF SO EQUIPPED).	5.point to the right spot?	Filter element cleaner (for use with water)
Dirty air filter in need of cleaning.	CHECK THE AIR CLEANER--CLEAN OR REPLACE ELEMENT IF NECESSARY.	6.*empty the dust unloading valve?	Defective or cracked dust valves

* Trainee must know all starred (*) items.



these aids were used as possible to add interest to the course and to help the trainee learn more easily and quickly.

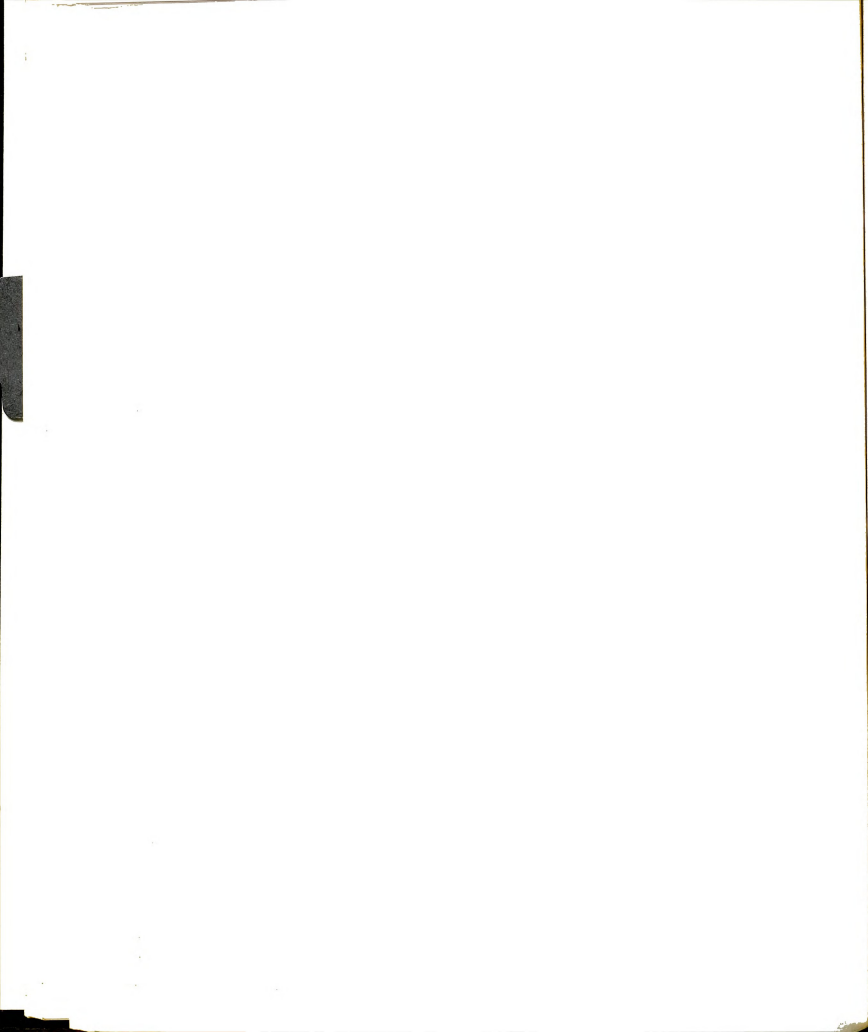
Teaching Aids and Audio- Visual Materials

Actual Objects

The best possible teaching material is an actual object. For training tractor operators there was no better object than the tractor itself. For this reason emphasis was placed upon an adequate number of tractors for each training class--preferably at least one tractor for each two trainees but not over four or five per tractor. The instructor had a tough job trying to keep four men meaningfully occupied while he attempted to instruct one man on the tractor; or while one man was performing practical work with the tractor, he kept the other four trainees busy and provided meaningful learning experiences for them without the tractor.

Parts and Components of Objects

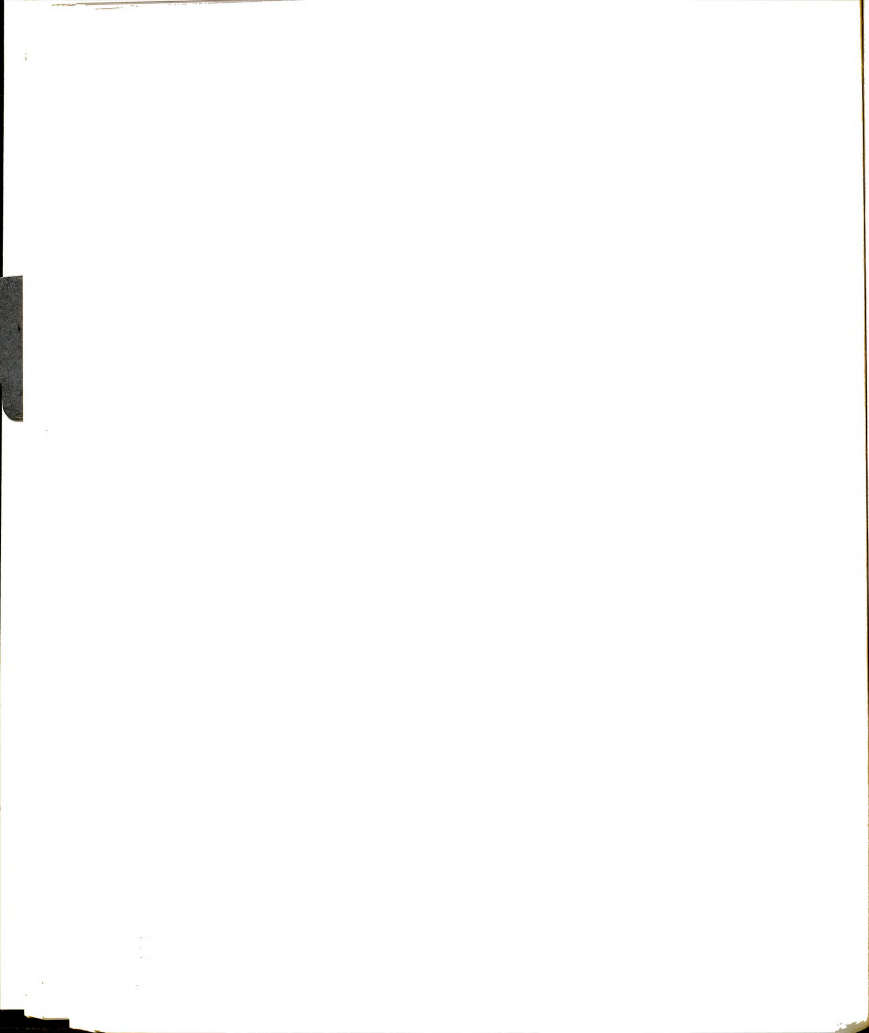
Junked parts of a tractor engine, transmission, drive train, etc., were shown to trainees to impress the need for maintenance. Indelible reminders were created by showing them gears, bearings, crankshafts, etc., which had been damaged or broken by neglect, carelessness, or harmful operation. A gear with one or more teeth broken



out made a visible and lasting impression on the trainee when he was shown what happens when he "clashes gears." Bearings worn out by lack of lubrication helped the trainee remember to grease the tractor regularly. Even though he understood only partially, damaged parts gave him a reason to perform maintenance services and do other things he had not been accustomed to doing prior to training. Disassembled parts also helped the trainee to understand how they look and fit together inside the tractor. In describing a piston ring, the trainee who has seen one and thoughtfully looked at it automatically recalls its picture in his mind when the instructor mentions it again.

Models and Visual Simulators

Smaller or larger scale models that work were used to show the trainee what happens when the engine fires or the crankshaft revolves. One of the best visual simulators produced for teaching the principles of the 4-stroke cycle diesel or gasoline engine is a single cylinder in two dimensions. It is available in colored plastic with moveable crankshaft, connecting rod, piston, and valves. It was used with a directional light source, such as an overhead projector, to throw a greatly enlarged colored picture in motion on a wall or screen. A similar simulator is available for the 2-stroke cycle engine. The cost of these models (with a book of black and white transparencies on the internal combustion engine) in the United States is

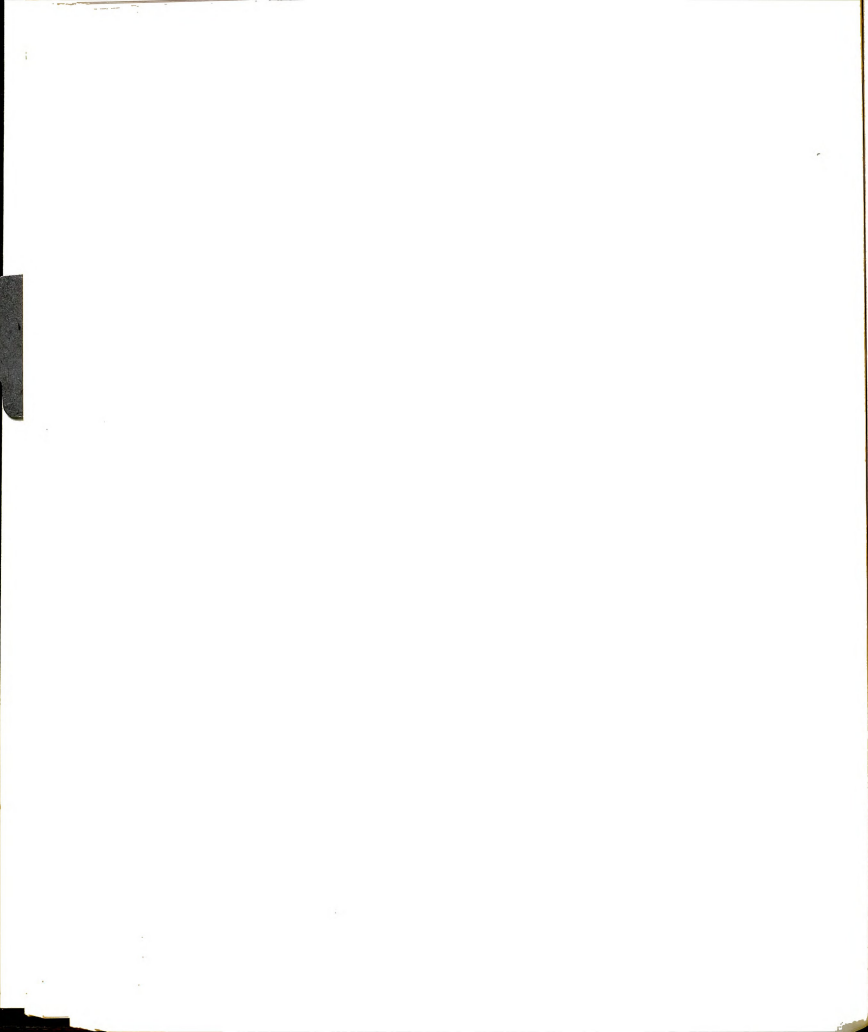


\$23.00 plus shipping from the 3-M Company, St. Paul, Minnesota. See Appendix A for more complete details on these visual aids.

Colored Slides and Filmstrips

Slides and filmstrips, preferably in color, were used to enlarge the trainee's vision to help him understand what goes on inside the air cleaner and other parts that cannot be easily visualized from the outside. In the Michigan State University Basic Tractor Operators' Course, certain key slides were used to add interest and variety to the large group presentations. Prepared slides also made it easier for the instructor to have certain well-made visuals readily available which he could explain in a personal show-and-tell conference and demonstration. A simple manually operated slide projector can greatly enlarge the picture so that everyone can see it without adding cost or complexity to the training program. Appendix A includes a list of suggested 2 x 2 slides.

In addition, to build rapport with the trainees, the instructor used his camera to record on film some of the activities and personalities that make up every training program. Everyone delighted seeing themselves in a picture, particularly, when it showed them happily doing something. Doing things well which are fun were characteristics of the training program.



Motion Picture Training Films

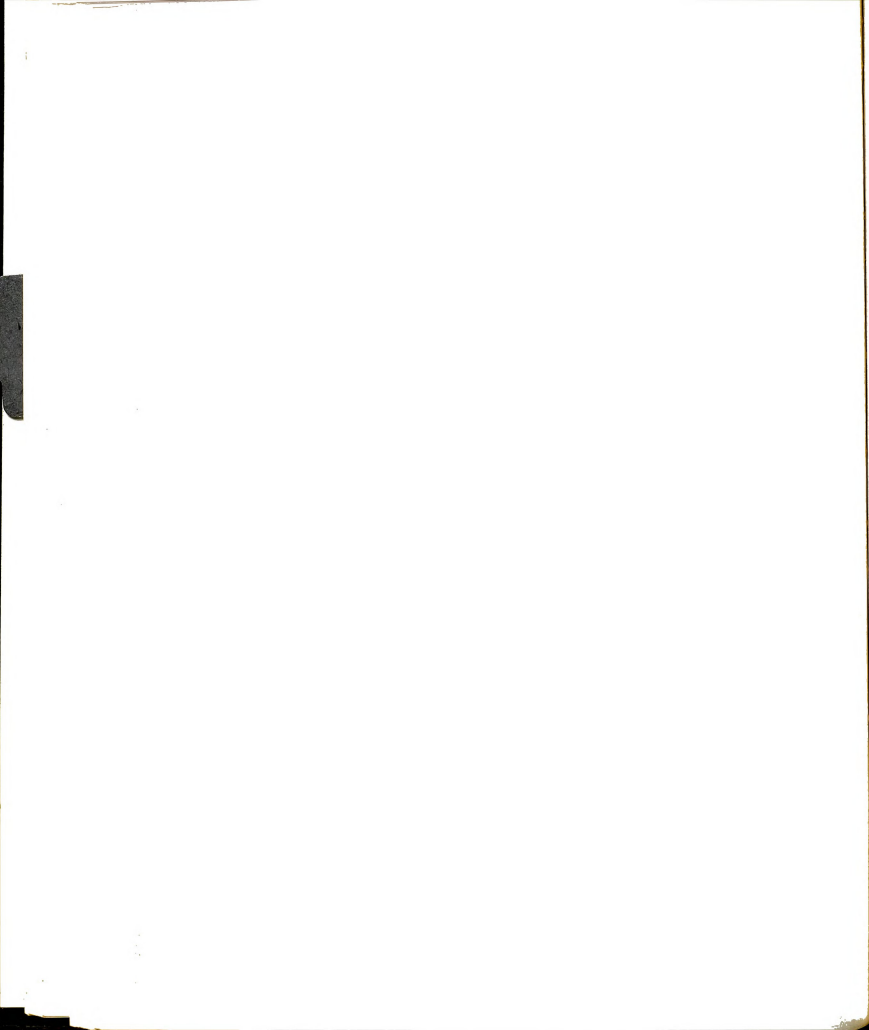
While training films were not included as part of the prescribed Structured and Learning Training Environment, there is no reason why the training director should not capitalize upon their use to enhance the after-hours school and job training situations. For instance, most major farm machinery manufacturers and their distributors in all countries have some very instructional and enjoyable color films. When asked, they will gladly show them with their own projectors to a school or training institute, extension meeting or other gathering. All the training director needs to do is contact them sufficiently in advance and provide a suitable indoor or outdoor setting with electricity. These films can be shown anywhere with a portable electric generator.

Other Teaching Aids

Other types of teaching materials and media were employed by the trained instructor whenever they provided an advantage, or an opportunity to more effectively reinforce a point. Some that were used are:

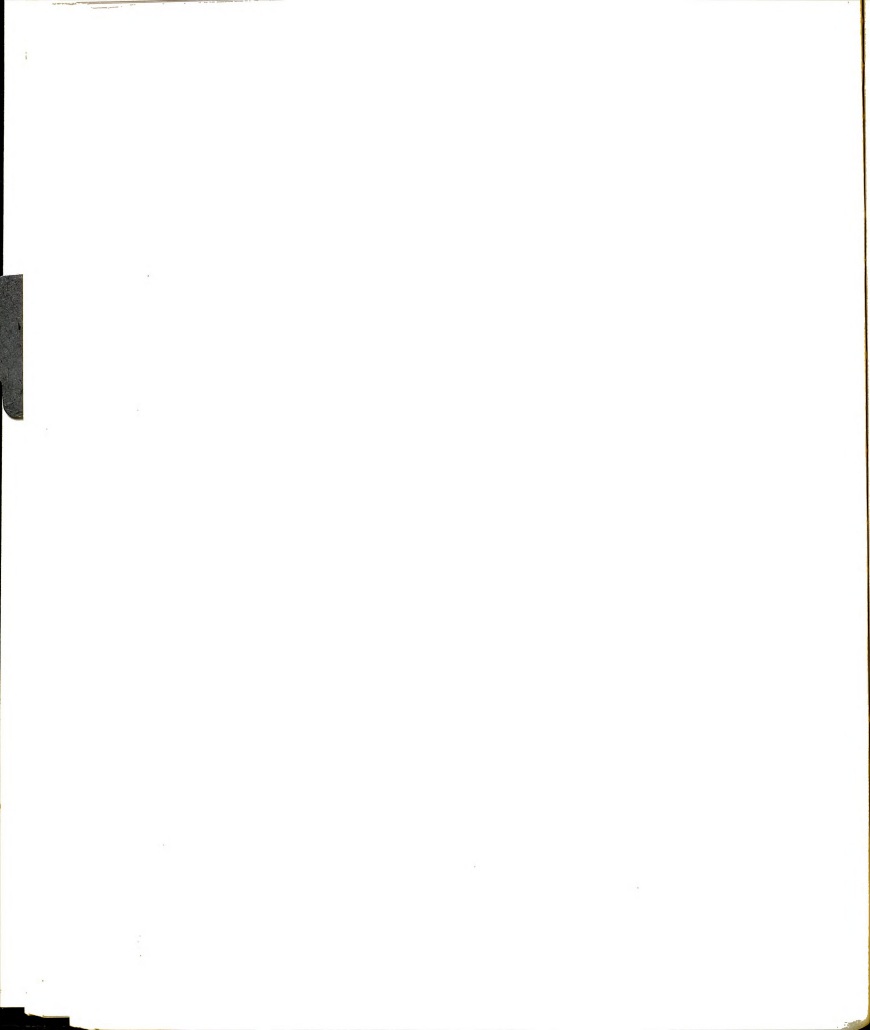
1. Large wall charts with exploded views in color and graphs available from many industrial and agriculturally oriented firms.

2. Sales and promotional literature handed out to trainees on a selected basis to whet their appetites and stimulate interest in new ideas and machines.



3. Owners manuals and other supporting teaching materials were effectively used with illiterate and semi-literate trainees to encourage them to read and "study" on their own. At the end of the course, a simple booklet in the trainee's language could be given to him to remind him of the main points covered during the course. Deere and Company have prepared a follow-up booklet in Spanish for the trainee's reference after graduation (1969). It stressed safe, intelligent, and economical operation, with special emphasis upon the required daily and weekly maintenance services which the trainee has been taught during the course. If his name is printed on it carefully with a felt-tip pen, he will treasure it and proudly show it to all his friends, as well as take pains to preserve it for later reference and use. The important point was to make it personal and to make him feel that he is important and has made a real achievement in becoming a qualified tractor operator. Such booklets were also developed by Bartlett (1963) with the South African Sugar Research Experiment Station.

4. All experienced instructors make effective use of the chalk-board, flip-chart, sand-box, bulletin board and similar instructional aids. Precautions were taken to make sure the illustrations were large enough to be easily seen by all trainees, and that they were clearly drawn or sketched to be readily understood. All sketches

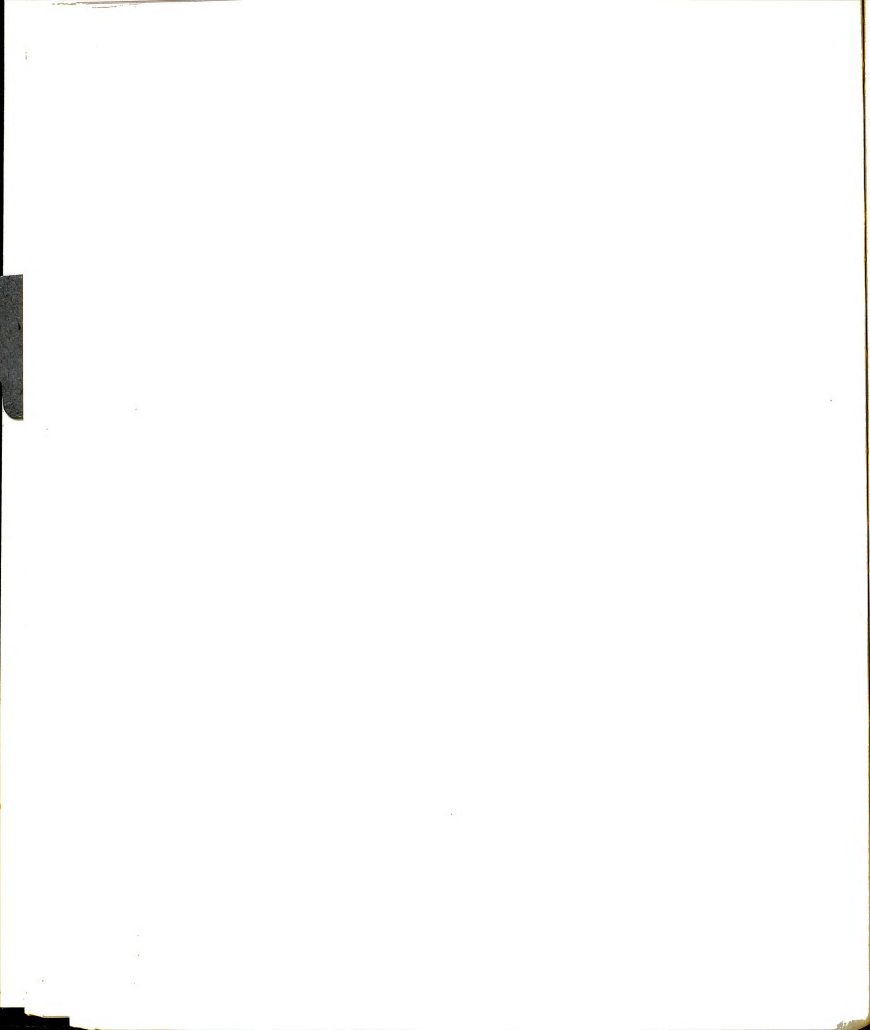


used were heavily marked or lined and positioned so they could be easily seen by all trainees. The instructors were cautioned to talk to the trainees and not to the black-board and to make sure that they did not turn their backs on them and muffle their words. The trainer was cautioned not to chew or smoke or do similar acts which cause him to speak indistinctly or garble his words. His rate of speaking was slow, measured and crisp, with variable tone and inflection. Maintaining eye contact was important to sensing the pulse of his audience and their mood.

5. See Appendix A for a partial list of suggested visual teaching and learning aids. Though not complete, it suggests possible types and sources of material now available. Interested instructors should write to individual firms on official school letterheads and request their latest catalogs and a copy of all available training materials in which they are interested.

Summary: The Design of a Specific Training
Program for Qualifying Low-Education
Level Trainees as Basic Tractor
Operators

Using the techniques of a modified SLATE (Structured Learning and Training Environment) and learning systems research, a detailed instructional program was developed for training instructors to teach low-educational level personnel to become qualified basic tractor operators. First, the functions of a basic tractor operator were defined in terms of job knowledge and skills. From these definitions, job

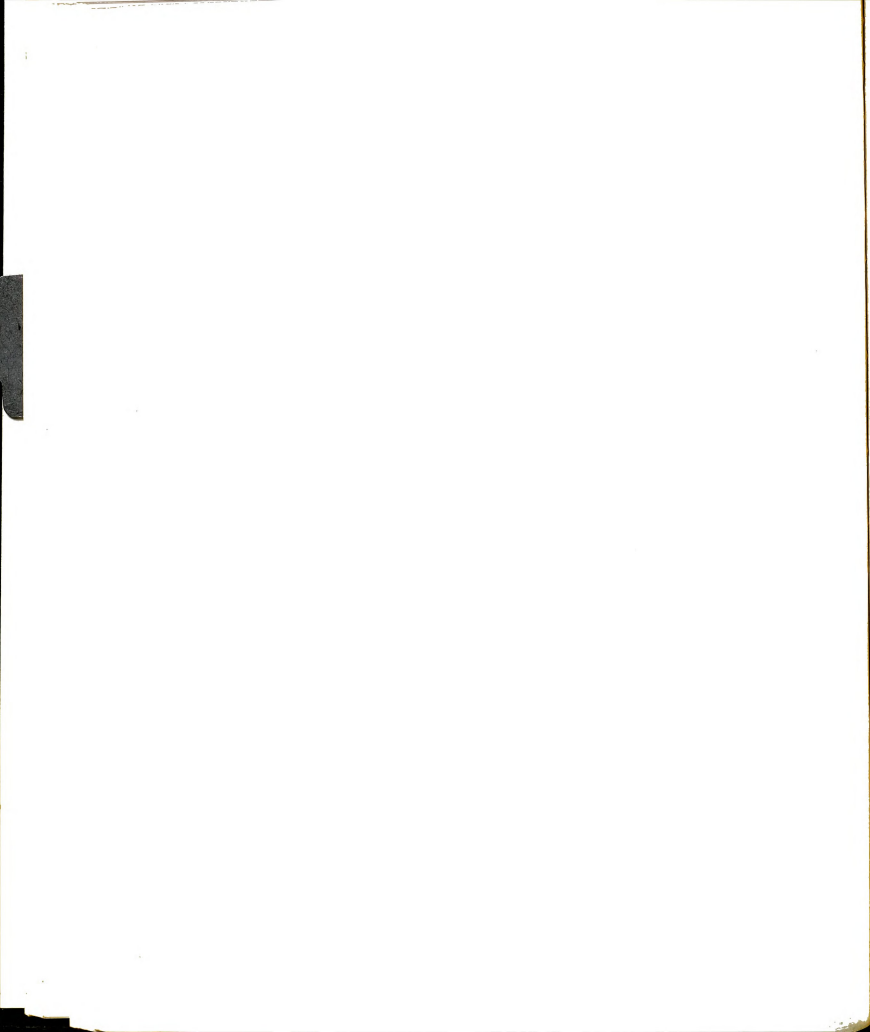


descriptions were written and broken down into specific tasks. Each individual task was outlined in a flow chart showing the order of performance and the skills and decisions required to perform the task.

Using the flow charts a brief lesson plan was prepared for each major skill or knowledge required. The Behavioral Objectives which define the goals for the trainees were listed first. Next, Information for Trainees was prepared as a guideline for the instructor to help trainees meet the objectives. Instructional Methods were also suggested, by which the objectives could be met most effectively.

Trainee Activity Sheets were prepared for use in small group sessions. These included specific directions and questions for the instructor to give to the trainees and a Teaching Checklist of the key points which each trainee should know. Certain required key points were starred with asterisks (*) which each trainee must be able to perform or know to qualify as a basic tractor operator. A list of possible Teaching (or visual) Aids was given suggesting slides, models, machine parts and demonstrations to make training effective and interesting.

A series of questions (usually 10) was prepared as a pretest for each lesson to determine the trainee's entry behavior level. The same questions were designed to be used as a post-test at a later point in the training

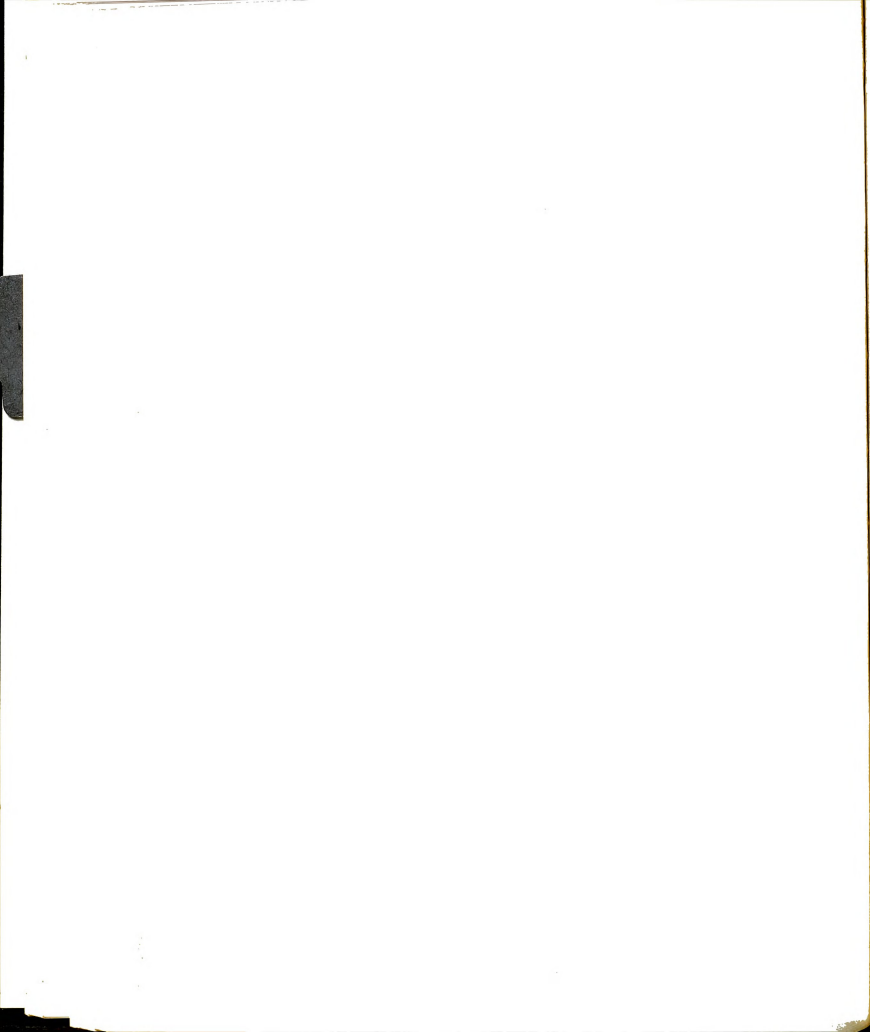


program to check comprehension and retention of the knowledge learned. The flow charts, also asterisked for required items, were designed to be also used as a post-test check of skill performance.

A Daily Trainee Evaluation form was prepared to allow the instructors to rate each trainee after the completion of each lesson. Included was a method to evaluate the trainee's attitude, skills, and knowledge. This form facilitated the detection of problems that the trainees were having and was the basis for measuring progress.

It was suggested that each trainee take the General Aptitude Test Battery (GATB) to determine his suitability and receptivity to training in machinery operation. These scores can be compared to the results of the training program to see if there is the expected correlation with success or failure in training.

A record of the trainee's progress and final rating was summarized on a Trainee Permanent Record to be retained by him for possible use in seeking employment.



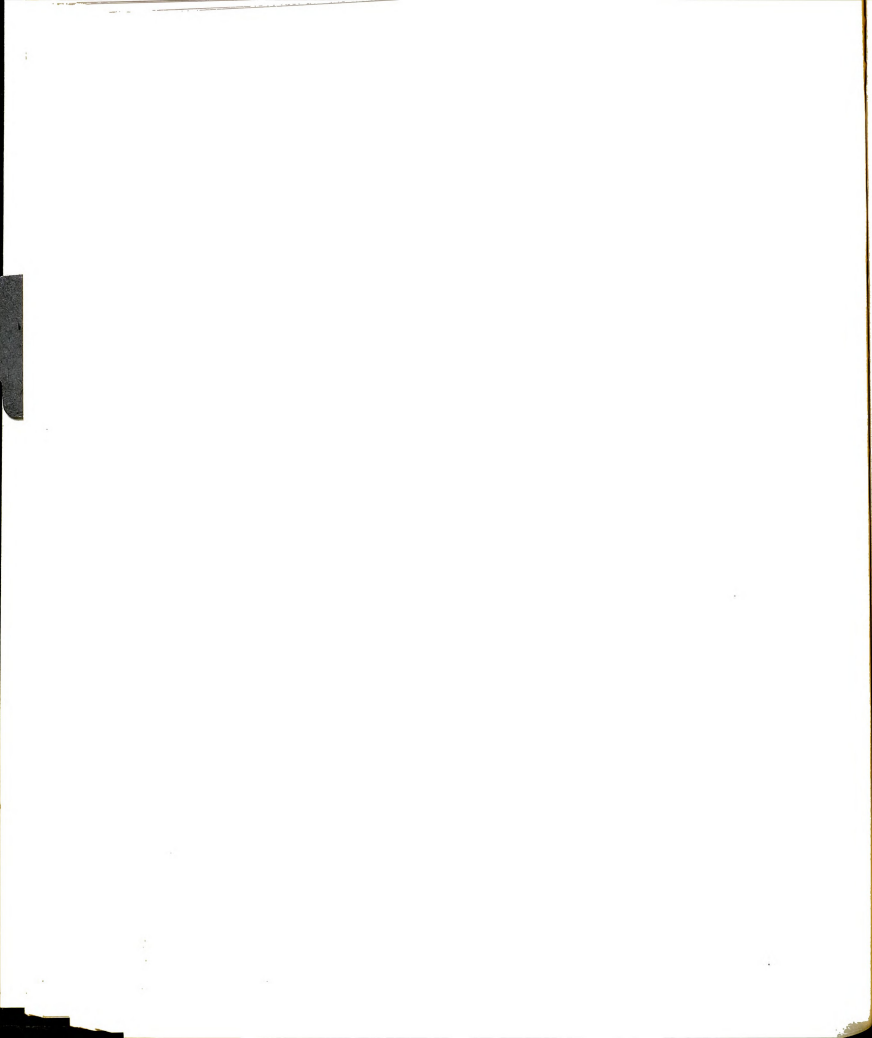
CHAPTER IV

TECHNIQUES AND INSTRUMENTS FOR EVALUATING TRAINEE ATTITUDES, SKILLS, AND KNOWLEDGE

General Concept of Evaluation and Testing

Evaluation is a means of gauging the extent to which objectives of a project of activity have been achieved. Course objectives lead to activities which must be evaluated. As soon as they were stated, ways of evaluating their achievement were considered. Activities were then chosen pertinent to the objectives and with consideration for their evaluation. Doll reiterates that the thinking process in instructional design should follow this sequence: "from objectives, to evaluation, to activities which are useful in achieving the objectives, and whose effects can be properly evaluated" (R.C. Doll, 1970, p. 147).

The purpose of education, according to Banathy "is to ensure the attainment of specified knowledge, skills, and attitudes--thus, learning is the purpose around which the system is to grow." In designing curriculums, he says it "is learning which should be in focus" (B. H. Banathy, 1968, p. 24). On the basis of this



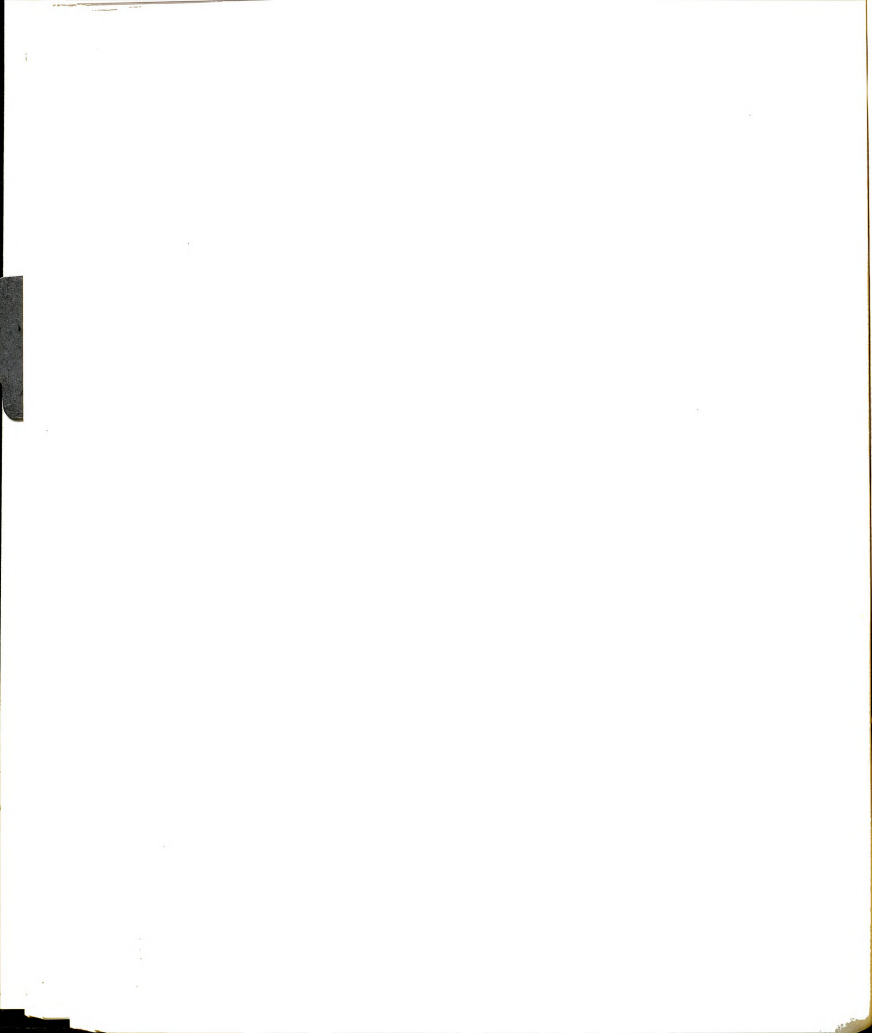
discussion, it is suggested that instruction is the process rather than the purpose of education.

From the systems view, instruction denotes processes and functions that are introduced into the environment of the learner to facilitate the mastering of specific learning tasks. Hence, any interaction between the learner and his environment toward the attainment of specific and purposeful knowledge, skills and attitudes was viewed as instruction. The effectiveness of an instructional system, therefore, was measured by assessing the degree it provided for the learner a system for learning. A training system serves its purpose to the extent that it brings about in the environment of the learner all the possible interactions that result in the attainment of the desired performance.

Won't Do Versus Can't Do

Training may be simply defined as an "attempt to influence behavior." Goss says "The effect of training should be to increase both the trainee's ability to do, and his willingness to do, the assigned job" (W. R. Goss, 1970, p. 46). Frequently overlooked is the fact that training and testing must prepare the trainee for the job environment as well as the job.

Training programs cannot be designed, conducted or tested in a sterile or imaginary environment. In industry or business, some indicators of personnel



problems and need for training are (1) low production rates, (2) high rejection rates, (3) high absenteeism, (4) large number of grievances, and (5) a high employee turnover rate.

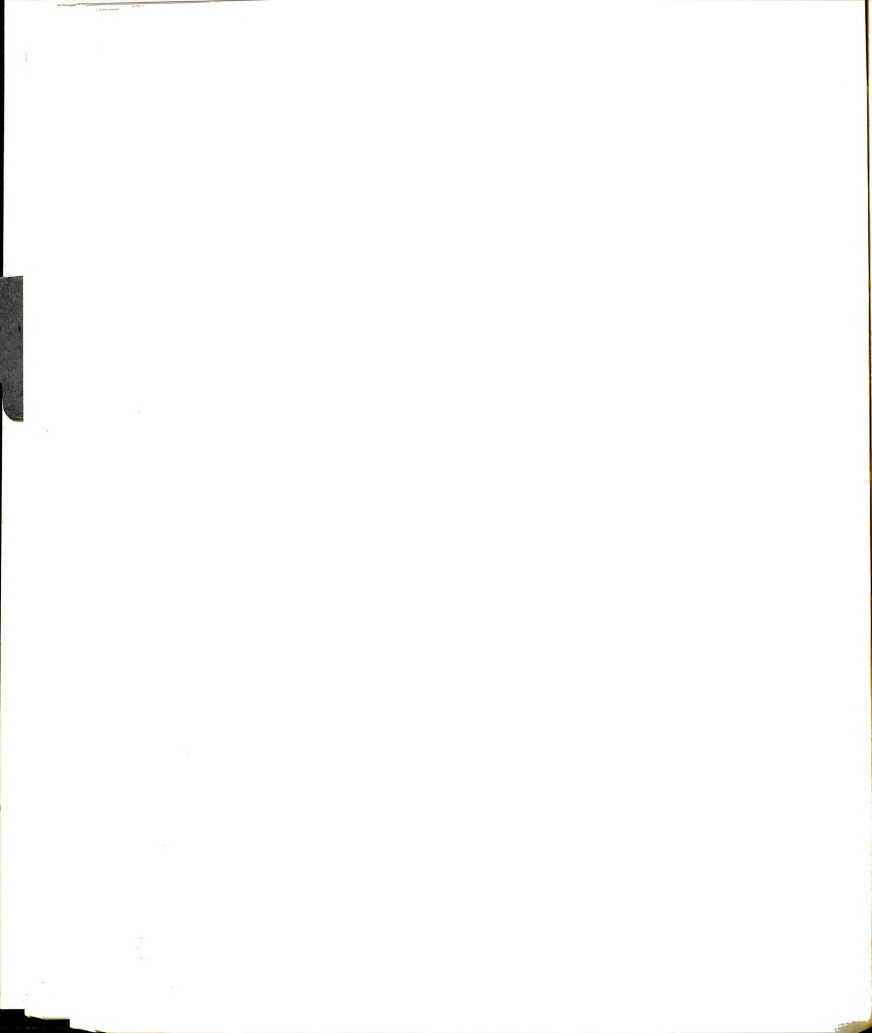
It is important to acknowledge, Goss (p. 46) cautions

that not all personnel problems can be solved by training. Sometimes it's a matter of 'won't do' rather than 'can't do.' Sometimes unsatisfactory performance is due to weaknesses in the system rather than lack of employee skill or willingness. Many a plant with high rejection rates has spent money on training, when they should have spent it on replacements for worn-out tools.

Before testing the trainer must look at the total training concept. To determine if the problem is won't do versus can't do, ask the question, "Given adequate tools, could the man do the job?" If he could but is not, then the problem is not a simple lack of skill or knowledge. Perhaps a simple aid is all the worker needs; or perhaps the supervisor is the one who needs training.

How Well Must Trainee Learn?

The problem must be verbalized before a solution can be developed. Without specific objectives, there can be no meaningful, definable accomplishment. Meaningful means measurable and trainers must not only identify what the trainee must know and what he must be able to do, but the tests must state how well he must be able to do it. The specific performance criteria are those demanded by the job as it is performed in the real world.



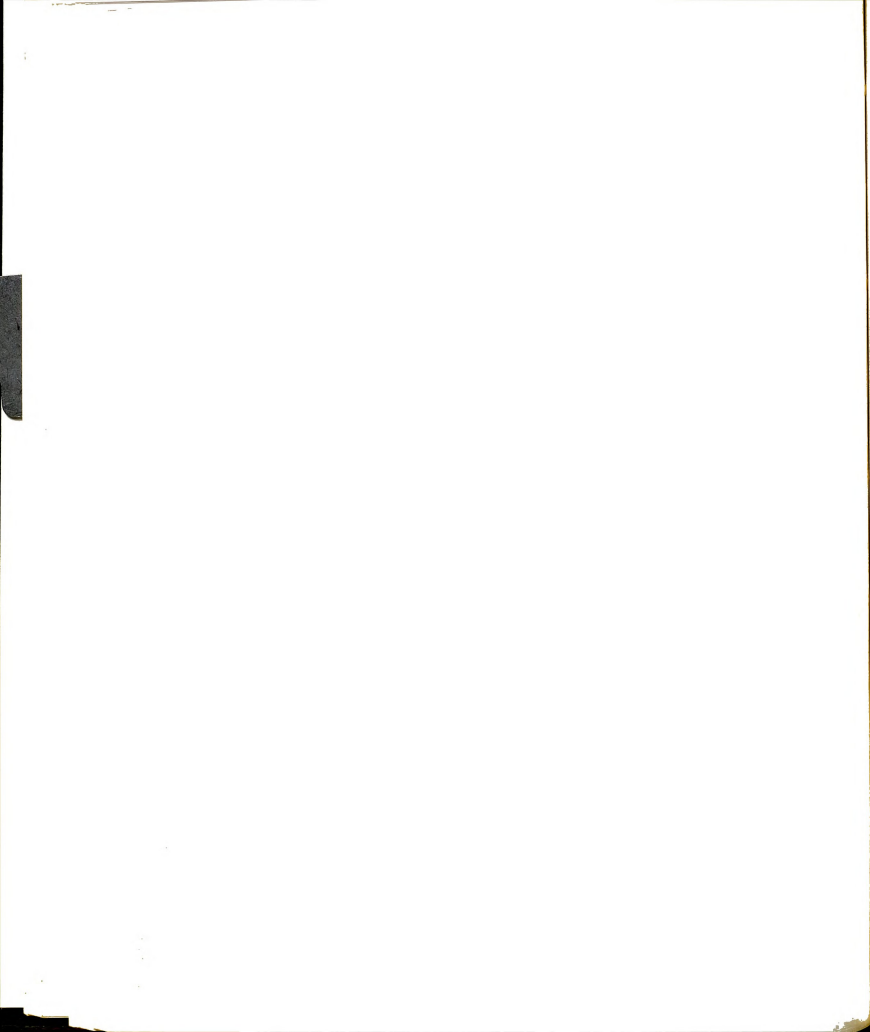
The evaluation of the achievement of objectives is sometimes short-circuited by moving directly to experiences through which objectives are achieved. However, the very means of evaluating objectives will suggest suitable learning experiences. This prevents instructors from getting lost in a forest of activities and experiences. It also keeps them from trying to develop tests to measure meaningless and extraneous material.

Evaluation procedures were designed to measure attainment of every desired behavior the objective expresses, such as changes in attitude, appreciation and interests which are difficult to assess. Pencil and paper tests do not fulfill this need; therefore, more ingenious test instruments and methods were devised to measure learning.

This chapter discusses the instruments developed specifically for measuring the effectiveness of training and the attainment by the learner of the stated objectives of the Basic Tractor Operator's Course, Grade I. Emphasis was placed on performance testing and standards for certification.

Aptitude Evaluation

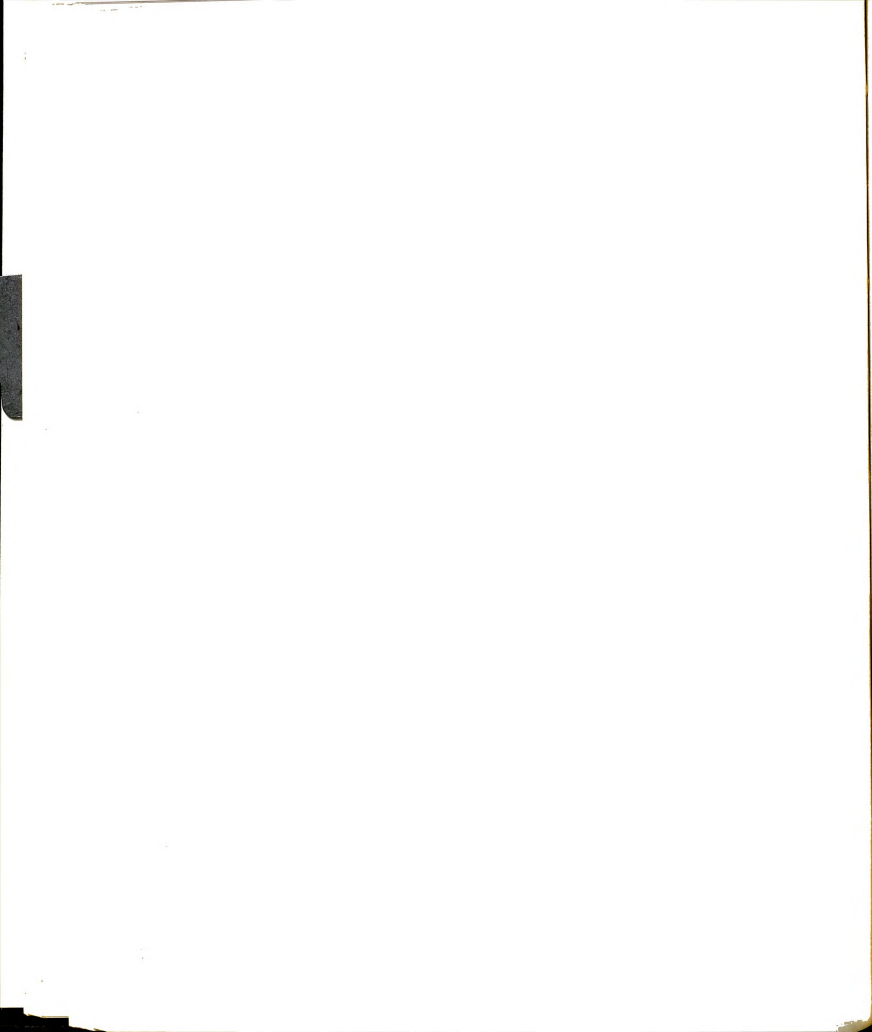
In recruiting and selecting trainees one of the first factors to consider is mechanical aptitude. Some



individuals possess little information about mechanical devices or their nature. Others have considerable aptitude in solving problems involving mechanical reasoning and in understanding the operation of mechanical things. Some people have a natural interest in, and a desire to learn more about, the mechanical arts and the technical crafts around them; while others are indifferent to various types of machines and have little or no curiosity about them. Various types of tests have been developed to identify persons who are mechanically inclined.

The use of occupational test batteries, together with other information obtained through proper interviewing and counseling, offers an objective measure of an applicant's potential skills and aptitudes for certain types of work. Testing helps to standardize the selection process and adds validity to the assessment of an individual's abilities in comparison with other individuals previously evaluated with similar characteristics. The selection of trainees for specific training programs on the basis of standardized tests is based on the fact that individuals vary greatly among each other physically, in ability to learn, in ability to produce, and in specific aptitudes or innate capacities. Where available such tests should be used as partial criteria for the selection process.

The experience background of the trainee gave an indication of his ability and aptitude in mechanical



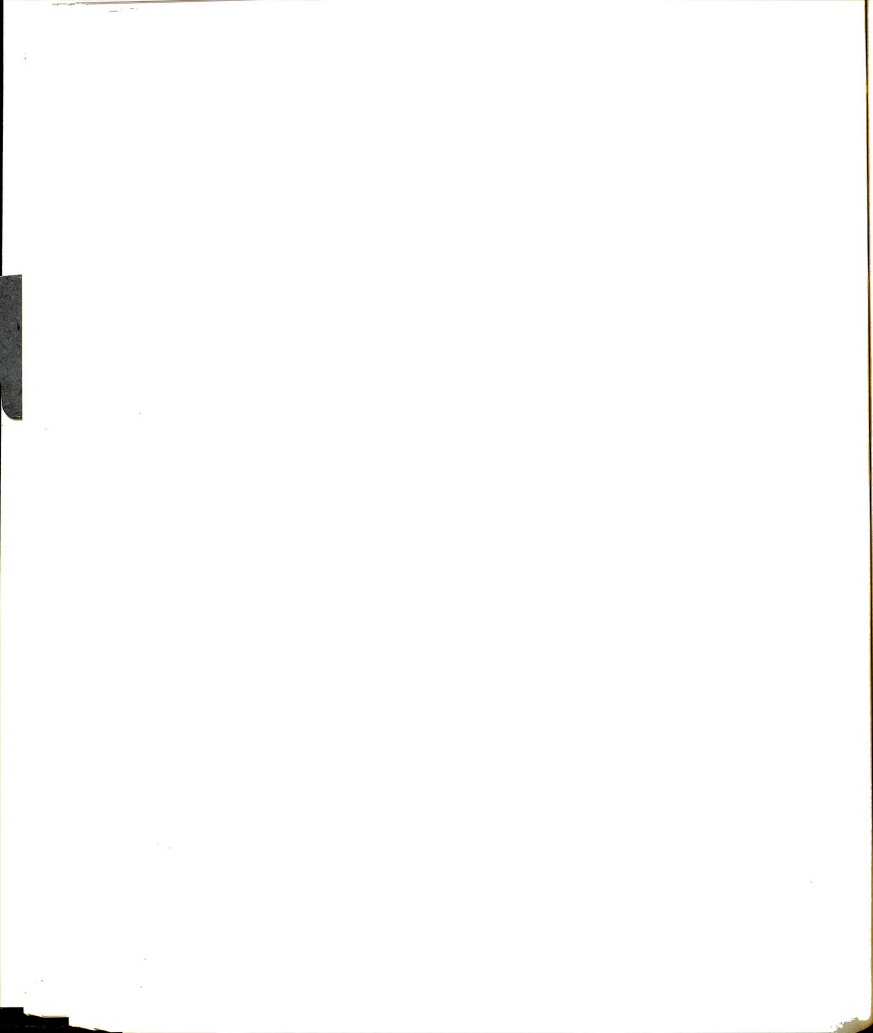
skills. For tractor operator trainees, much of this information was obtained through a personal interview using the suggested enrollment form (Appendix C).

Since trainees' backgrounds are so varied around the world, it is impossible to set general minimum standards for entry into the training program. However, for greatest success in training, preferred candidates should:

1. Have a minimum of a 4th or 5th grade education or its equivalent.
2. Be a minimum of 15 years of age with special consideration given to middle school leavers.
3. Be interested in agriculture and vocational training for an agricultural occupation.
4. Have a job opportunity where they can be employed upon satisfactory completion of the training course.

Each trainee, in addition must:

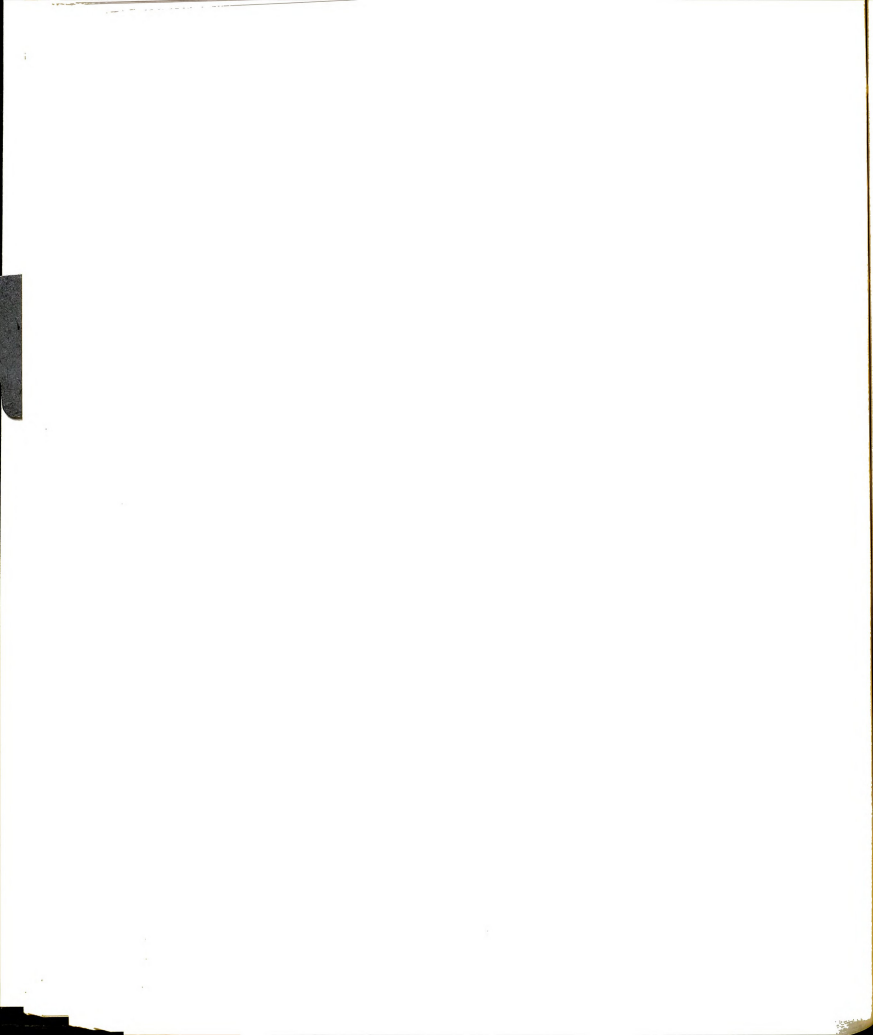
1. Have the consent of parent or guardian to take training if under age.
2. Agree to, and have the means, to stay until the course is completed.
3. Have arrangements for transportation to and from the training site.



Use of Occupational Tests
and Test Batteries

Occupational training tests--such as the US Employment Service General Aptitude Test Battery (GATB), the Differential Aptitude Tests, Purdue and Minnesota Tests--are one means of measuring a person's ability to acquire specific job skills and knowledge. Tests measuring job potentiality are called aptitude tests and measure an applicant's learning ability for jobs which require no previous training or experience. Different tests may be combined in a test battery to measure the aptitudes of inexperienced trainees to take special training to acquire specific skills for a number of jobs or occupational clusters.

There are over 200 validated tests in the Michigan Employment Security Commission's Test Division for many occupations. It is desirable to use tests relating to a group or cluster of jobs, since changing technology demands that workers have the ability to perform in several related jobs. Furthermore, the specific identified occupations already number over 40,000 and it is impossible to set up a separate test for each one which could be taken meaningfully by an applicant. But, tests can be taken which survey groups of occupations to determine his suitability for training in the general area. The safe and skillful operation of complicated



mobile machinery in agriculture or industry is an example of a cluster of occupations requiring special skills and special training for an operator to become qualified to perform them.

Advantages of Occupational Tests

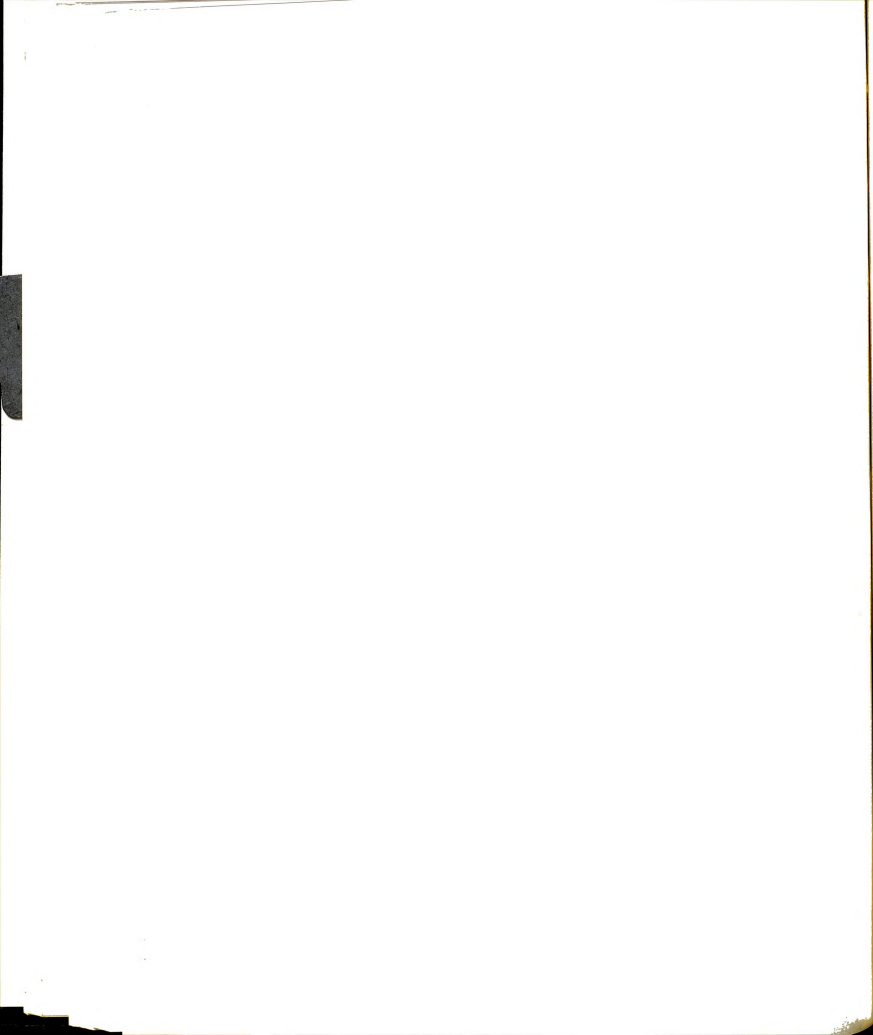
According to the Federal Employment Security Commission, some of the advantages of using carefully designed and administered occupational pretests are:

- a. Trainee abilities can be more appropriately matched to job requirements or skill areas.
- b. Test-selected applicants of highest performance can reach a higher level of training skills with the same amount of training.
- c. Test-selected applicants of high performance can reach a given level of skill with less training.
- d. The productive capacity of the individual can be forecast with reasonable accuracy.
- e. It increases the trainee's self confidence and builds morale and competence.
- f. It reduces the requirements for training and reduces waste in materials and resources.
- g. Tests do not require any previous experience or training.
- h. The tests indicate what type of on-the-job training may be suitable for newly recruited workers lacking developed skills.
- i. The tests are very useful in selecting trainees for vocational courses (US Department of Labor, 1968, p. 125).

Pretraining Tests

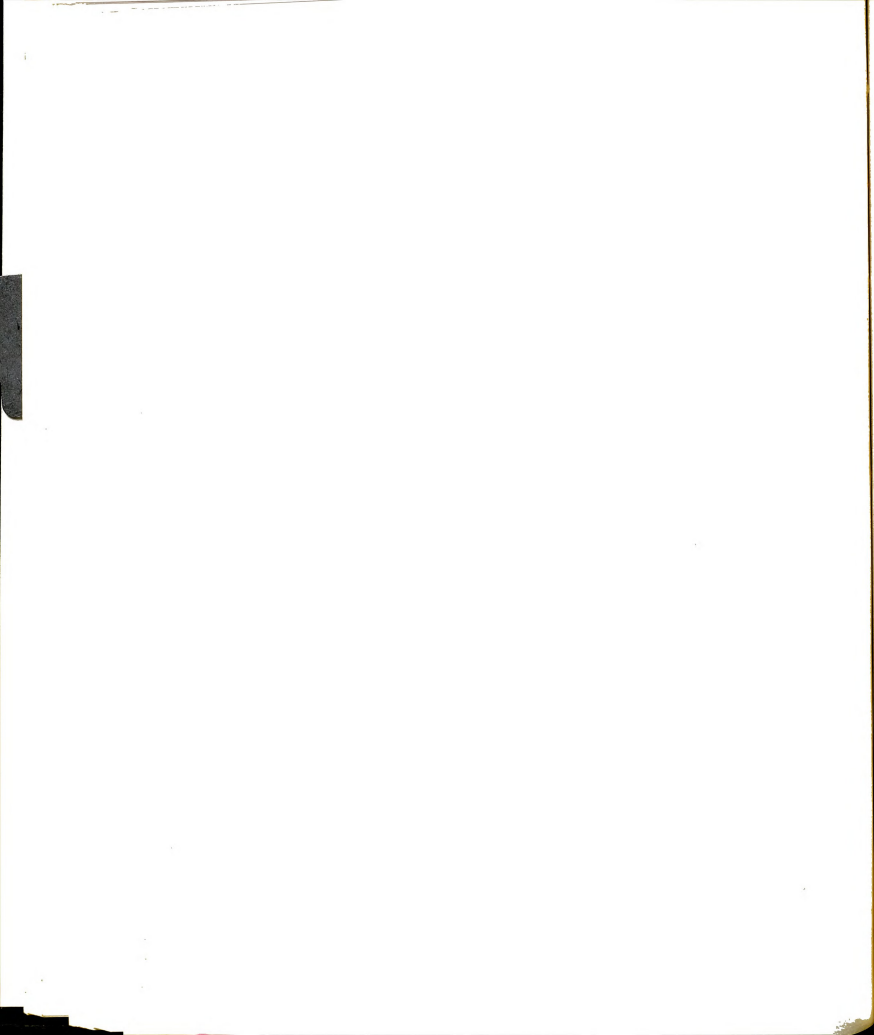
Mechanical Aptitude Tests Currently Available

The Detroit Mechanical Aptitudes Examination,
Form A (H. J. Baker, P. H. Voelker, and A. C. Crockett).--



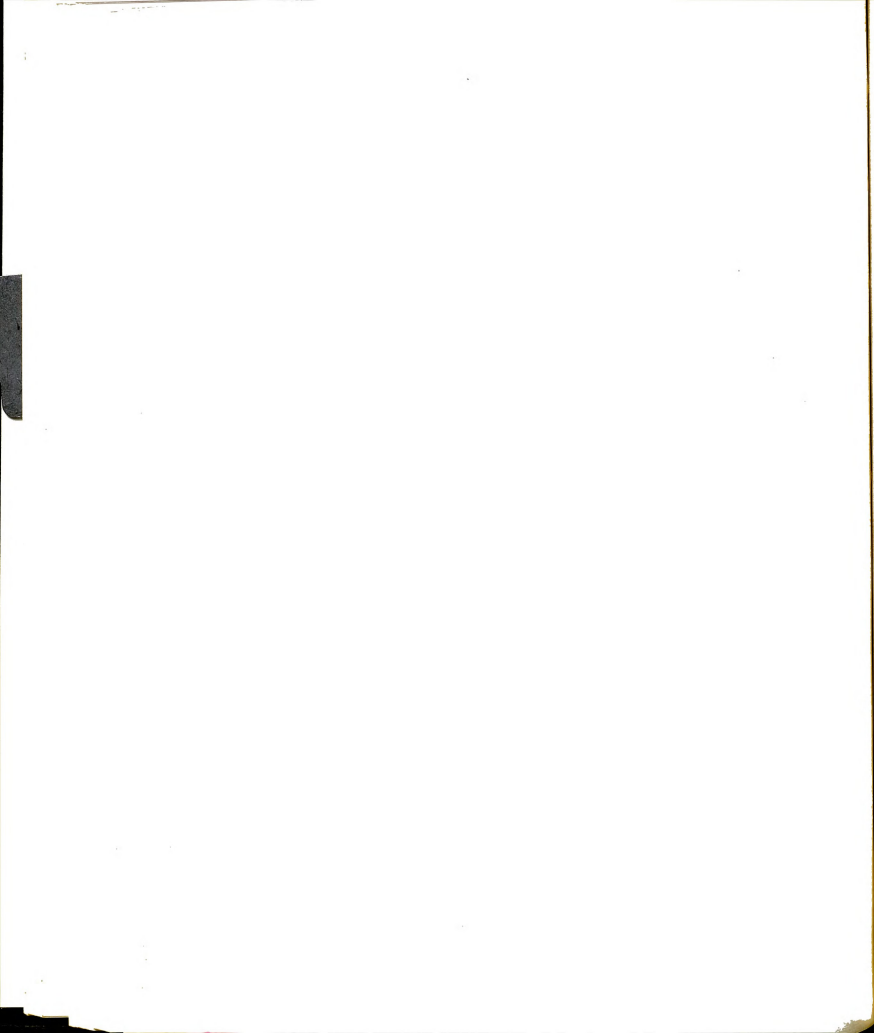
Parts of this test would be unsuitable for low-education level trainees since it requires a reading and mathematics knowledge too advanced for the average disadvantaged trainee. It consists of seven parts: (1) matching pictures of tools with the correct word description, (2) filling in or marking a series of blank circles, (3) determining the relative size of similar objects of the same form, (4) working simple mathematical problems, (5) fitting pieces of pictures together in the proper relationship, (6) multiple-choice questions on tools, mechanical devices and processes, and (7) determining the direction of rotation and speed of two belted pulleys in various combinations. See Appendix B for sample test pages.

The Purdue Mechanical Adaptability Test (C. H. Lawshe and J. Tiffin, 1964).--This test also requires an extensive English vocabulary and knowledge of mechanical processes. It uses no pictures or photographs but simply asks questions which can be answered by a Yes, No, or Don't Know response. The test deals with information of a mechanical, electrical or related nature. People who know the answers to these questions can do certain jobs better. Conversely, many other jobs can be done just as well by people who do not know the answers. The test allows 15 minutes to answer 60 questions. See Appendix B for sample test pages.



The Revised Minnesota Paper Form Board Test, Series AA (R. Likert and W. H. Quasha, 1941).--This test consists of 64 geometric figures divided or cut into various size and shaped parts. The parts are arranged irregularly in five squares with only one square of the five unasssembled parts having the right size and shape parts to make the correct figure. The trainee must decide which figure shows how the parts fit together to make the solid figure. Sometimes the parts have to be turned around or turned over in order to make them fit. The parts are cut from simple geometric figures such as triangles, circles, squares, parallelograms, diamonds and crosses. They progress from simple two-part straight line cuts to five-part multiple curve and line cuts. The trainee has 20 minutes to answer 64 problems. See Appendix B for sample pages of the test.

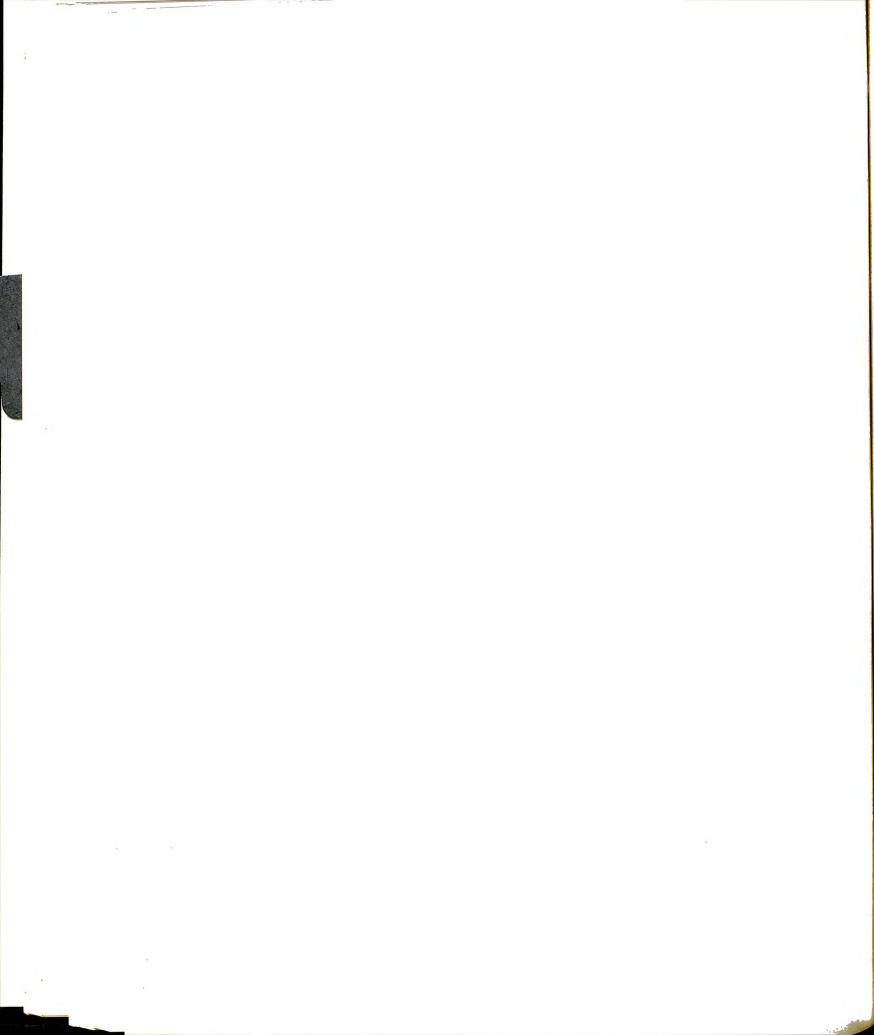
The South African Form Series Test (F.S.T) (R. H. Blake, 1970).--This non-verbal performance test measures the inductive reasoning ability of semi-literate Bantu workers. The subject is required to infer from a given sequence of symbols how this sequence is continued. The test has been in use for a number of years for classifying and selecting Bantu workers for a number of secondary industries in South Africa and adjacent countries. It consists of four practice items and 18 test items. The items are in a form of a pattern or



sequence of symbols. Each symbol has a particular size, color and shape. In the test, three sizes--big, medium and small--and three colors--red, yellow and blue--and three shapes--circle, square and triangle--are used to develop a coded sequence. Part of a sequence is presented and the trainee is required to continue it by fixing the plastic discs onto a strip of masking tape. The test items become more and more difficult as the test progresses. Instructions are given verbally in the subjects' native language with the aid of two demonstration posters. The test is administered only to Bantu industrial workers falling into the educational range from nil to about fifth grade level. It takes about 35 minutes including 10 to 15 minutes for instructions.

General Aptitude Test Batteries

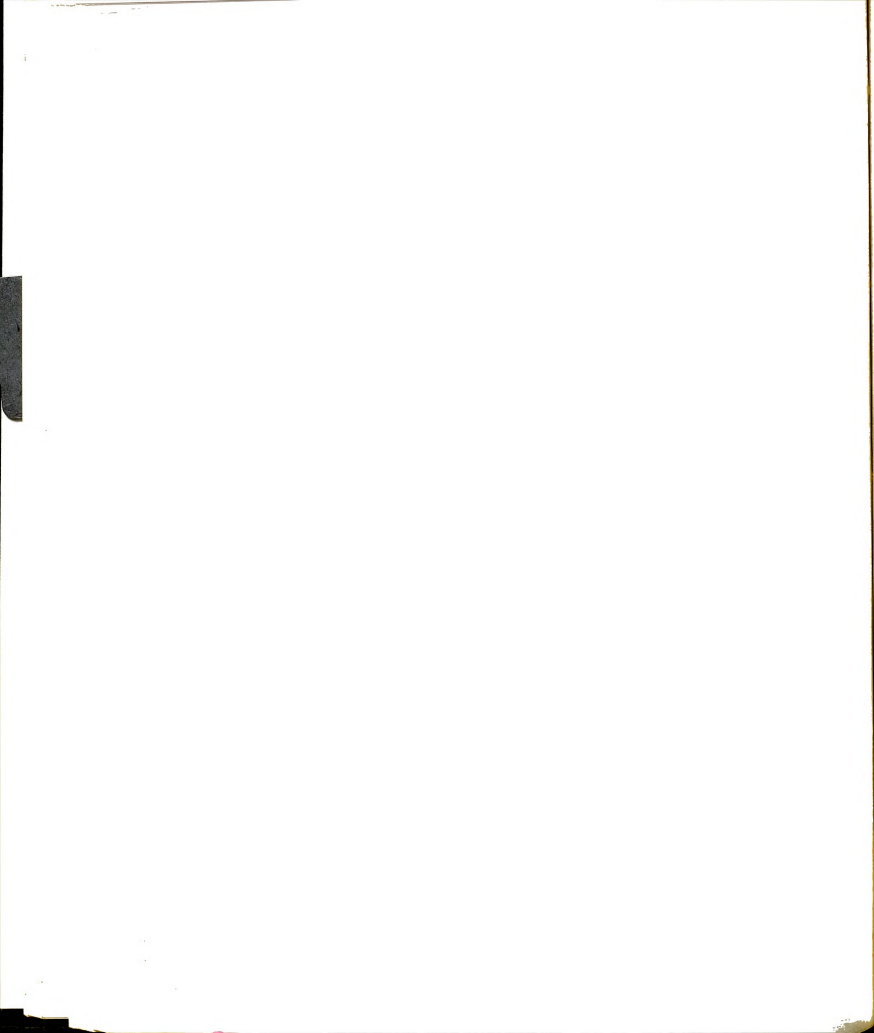
The US Employment Service General Aptitude Test Battery (GATB) (1970, p. 19).--To help establish individual entry behavior characteristics, all trainees enrolled in the Basic Tractor Operators Course should be given a series of general and mechanical aptitude tests. One widely used test in the US, the GATB, was developed by the US Department of Labor. In the US this test is administered by the local office of the State Employment Security Commission. Overseas, the training officer would give and interpret the results of this or



similar tests. The tests should be given prior to the start of the training program so that the instructor can obtain some idea of the general ability of and the variability among applicants. See Appendix B for sample pages.

After completion of the Basic Tractor Operator's training program (3 to 4 weeks full time), it was suggested that the GATB be given a second time and the results compared to the original test to determine any positive change made during the intensive training program. The first test would predict or identify those trainees most likely to do better than average, as well as those least likely to do well. These predictions can be compared to the results of the BTOC to see if they correlate with it in identifying above average potential operators trainable with a minimum of expense and time, as well as weeding out those unlikely to make good.

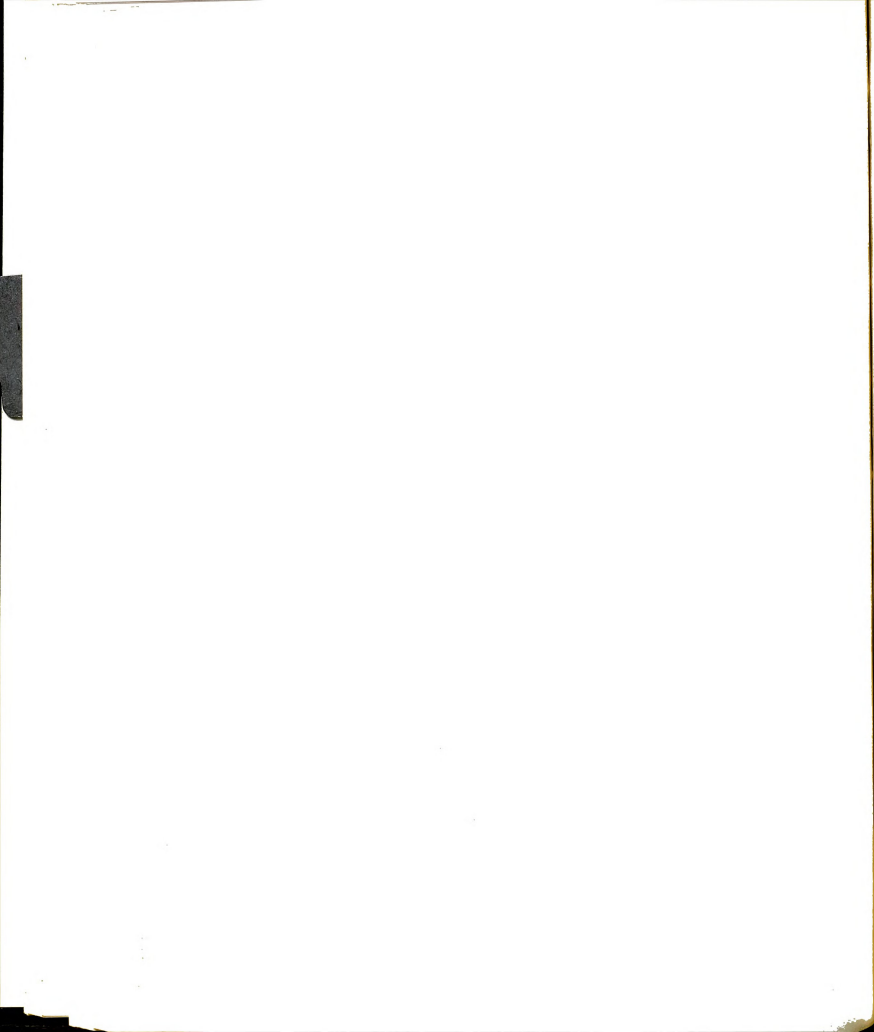
It is difficult and risky for people with little mechanical background to use tests developed in another country with a high level of technology. But there may be certain parts of multiple battery tests which are just as valid for them. The purpose of preliminary testing is to see if basic aptitudes can be measured under controlled conditions to predict the most promising trainees.



The present verbal GATB tests include: the general learning ability verbal tests on "vocabulary" and "arithmetic reasoning," a numerical test on "computation" and a "clerical perception test" on name comparison. The non-verbal GATB tests which are believed suitable for testing foreign-language applicants for training as tractor operators are:

1. A general learning ability spatial test on "3-dimension space"
2. Two form perception tests on "tool matching" and "form matching"
3. Two manual dexterity tests on "placing" and "turning"
4. Two finger dexterity tests on "assembling" and "disassembling"
5. One motor coordination test on "mark making."

In giving these aptitude tests it is important that the very same procedure and manner be followed each time by the testing examiner. It is desirable that the same person give the entire battery of tests to all trainees to be compared and trained in the same environment. To control error, the examiner should use the same number of practice sessions, offer the same encouragement and interest to relax the trainees and spur them on to their best efforts.

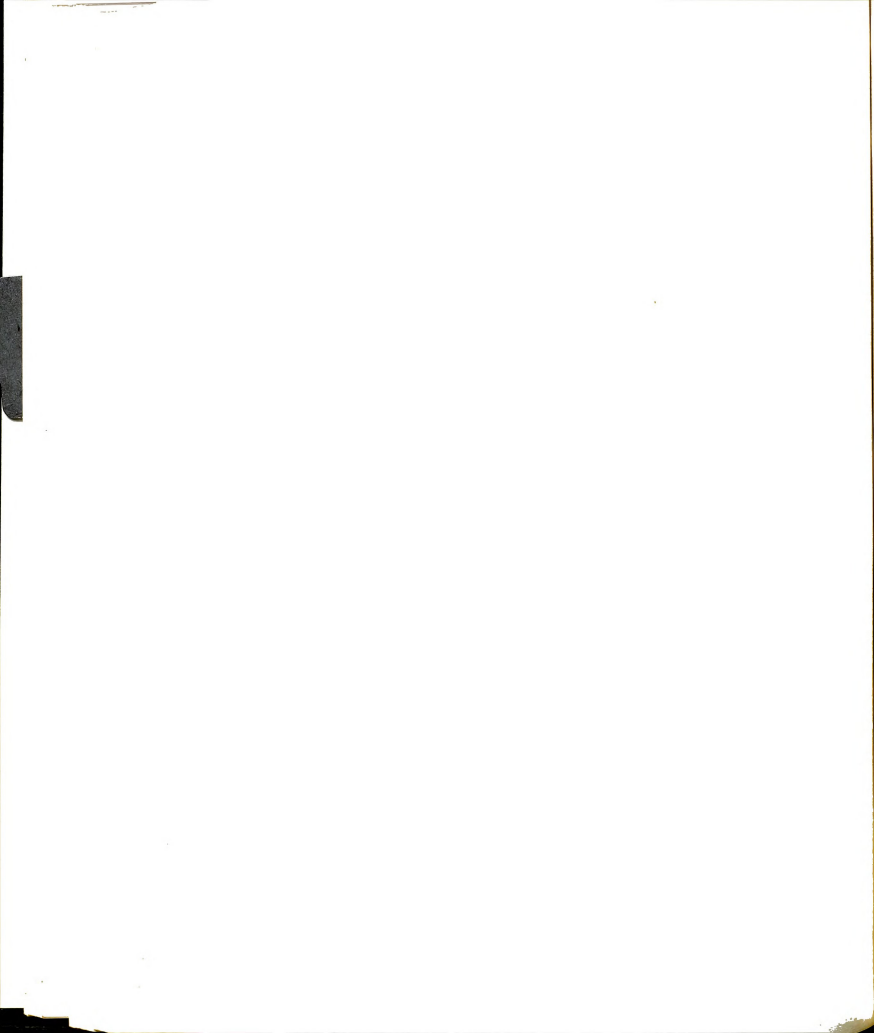


A special form EV-1 (Appendix C) was prepared to record the GATB tests for each applicant. The raw test scores were to be converted to standard test scores for basis of comparison. Based on these scores, comparisons could then be made between trainees and with other population groups having similar characteristics.

Special Aptitude Test Battery (SATB).--Trainees who have at least a fifth-grade reading level in English can take the entire battery of 12 GATB tests. For trainees with little or no formal education, or education in a different language, the Employment Security Commission suggested that only the eight non-verbal parts of the GATB be used.

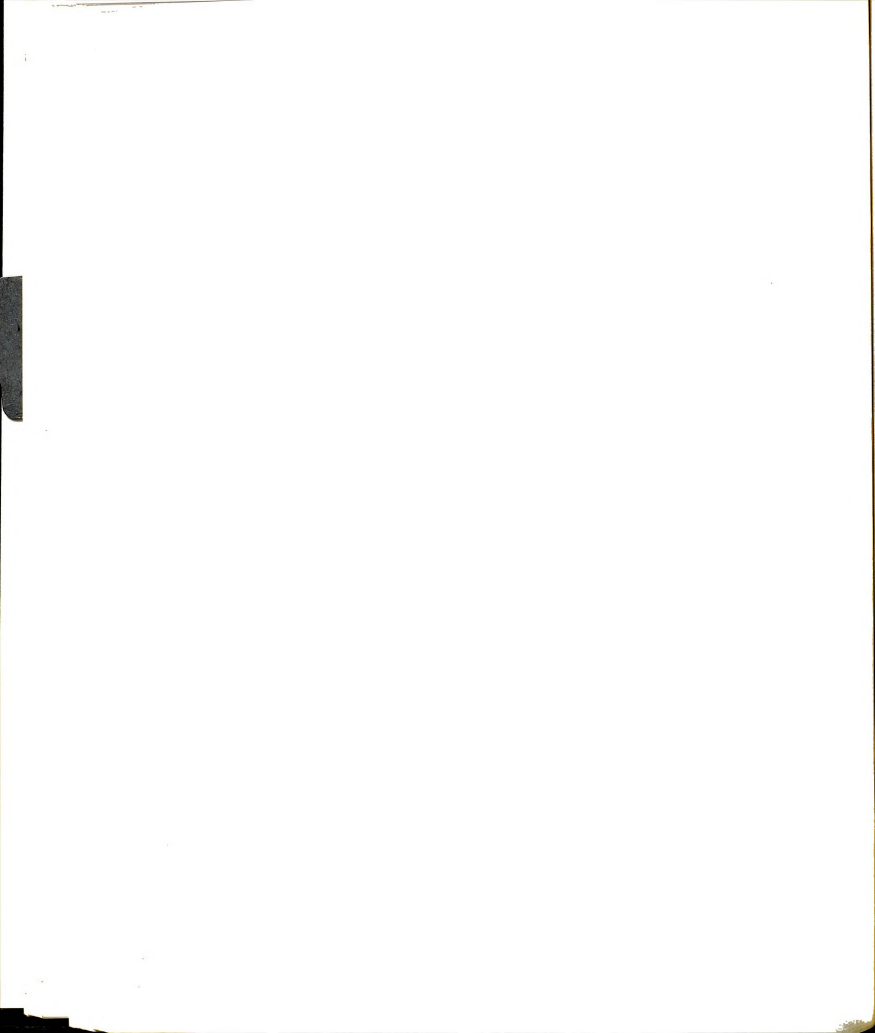
A new non-verbal version of the GATB, called the Special Aptitude Test Battery or SATB, was scheduled to be released during the summer of 1970. When available, this test can be used with trainees with less than a fifth-grade reading level. This test still has not been released as of the date of this writing.

For use in Latin American and other Spanish-speaking areas, there is a Spanish language GATB. Arrangements for it must be made well in advance and the testing officer must be trained and certified by the particular State Employment Security Commission. The examiner must also be well versed in the Spanish language.



Six aptitudes which will be measured by the Special (non-verbal) Aptitude Test Battery are: (1) general intelligence, (2) spatial aptitude, (3) form perception, (4) motor coordination, (5) finger dexterity and (6) manual dexterity. For a more detailed description of these aptitudes and the tests which are used to measure them, see Appendix B, for the nine aptitudes measured by the 12 tests in the General Aptitude Test Battery. Also see Appendix B, for definitions of the aptitudes measured by the GATB.

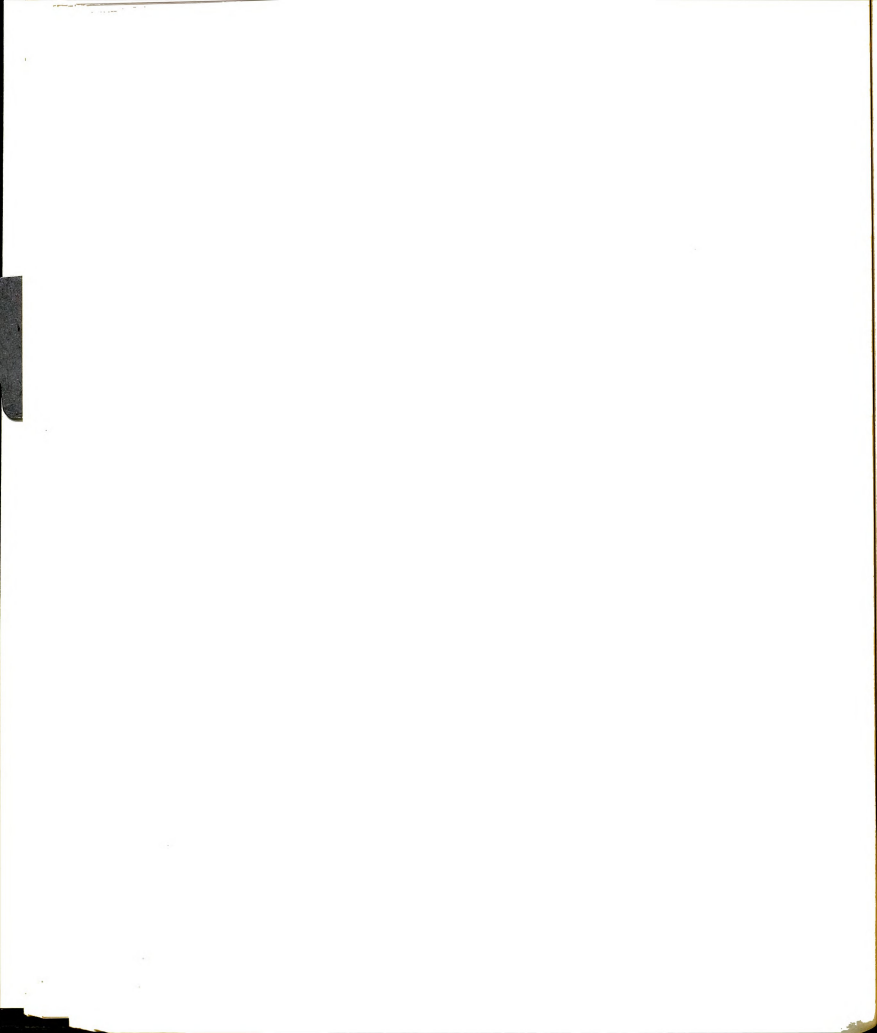
Aptitude tests do not pin-point for the trainee exactly what career he should follow or give exact answers to specific questions, such as: Can I be an engineer? or Should I plan to become a tractor operator? They can give reasonable answers to more general questions such as: What would be the better job for me--office worker or tractor operator? Do my particular assets fit the requirements for a mechanic? It should be kept in mind that any test is not a perfect predictor for all people. It does not tell a trainee who scores low that success is impossible. It does inform him that he may have a tougher time than his classmates and is not very likely to do well. A boy who gets a high score could also fail because of laziness or other reasons not related to his ability measured by the tests.



The Differential Aptitude Tests (DAT) (G. K. Bennett, H. G. Seashore and A. G. Wesman, 1947).--DAT measures verbal reasoning, numerical ability, abstract reasoning, clerical speed and accuracy, mechanical reasoning, space relations, language usage spelling and language usage grammar. These tests of an individual's capacity to learn help predict how he can expect to develop in school and in a job by evaluating his relative strengths and weaknesses as they may affect his progress. The results of DAT tests should be used along with other information such as school grades, hobbies, interests, ambitions, character qualities, personality traits, health, ability to work with others, skill in doing hard tasks and willingness to learn.

Verbal reasoning: This test tells how well a person understands ideas expressed in words and how clearly he can think and reason with words. It is probably the best all-around predictor of how well trainees can do in school. Trainees who score well should consider more advanced education. Persons who do poorly should perhaps go into work calling for less verbal ability, such as production work in a factory or on a farm without expecting to become manager.

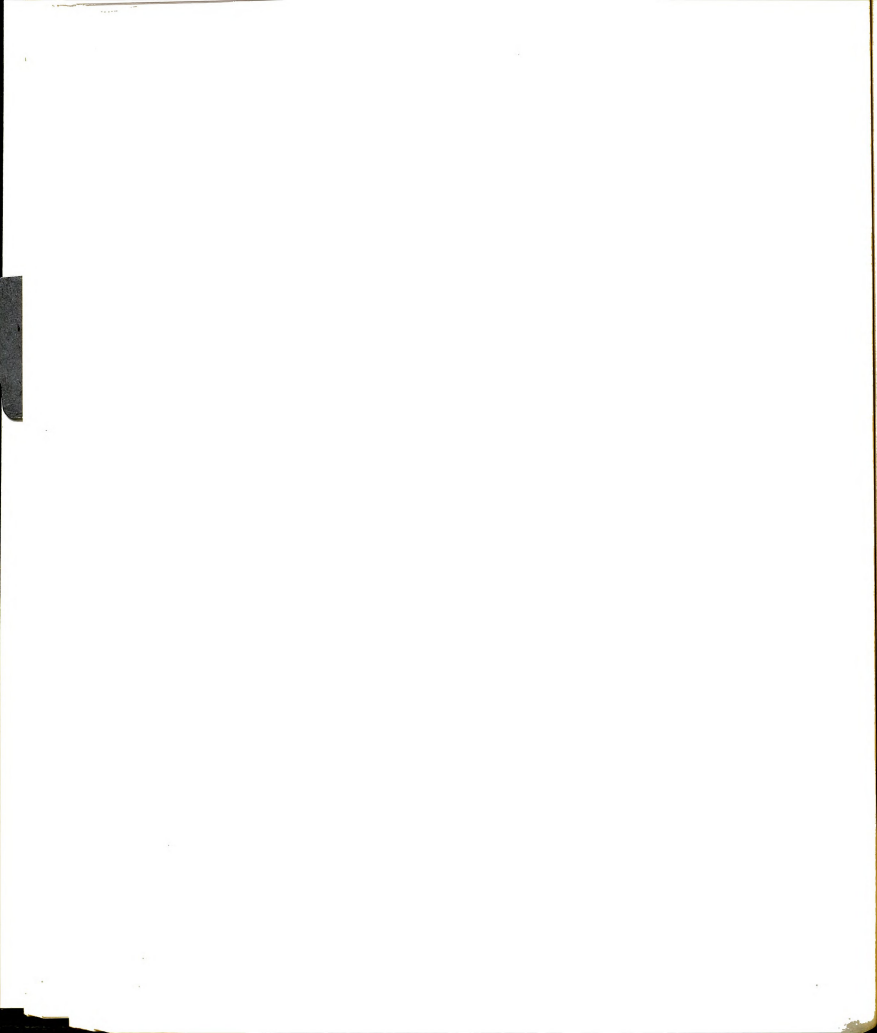
Numerical ability: This test tells how well a trainee understands ideas expressed in numbers and how clearly he can think and reason with numbers. Scores on



this test predict, to some extent, success in nearly all high school and college courses. It is useful in technical careers not requiring a college degree.

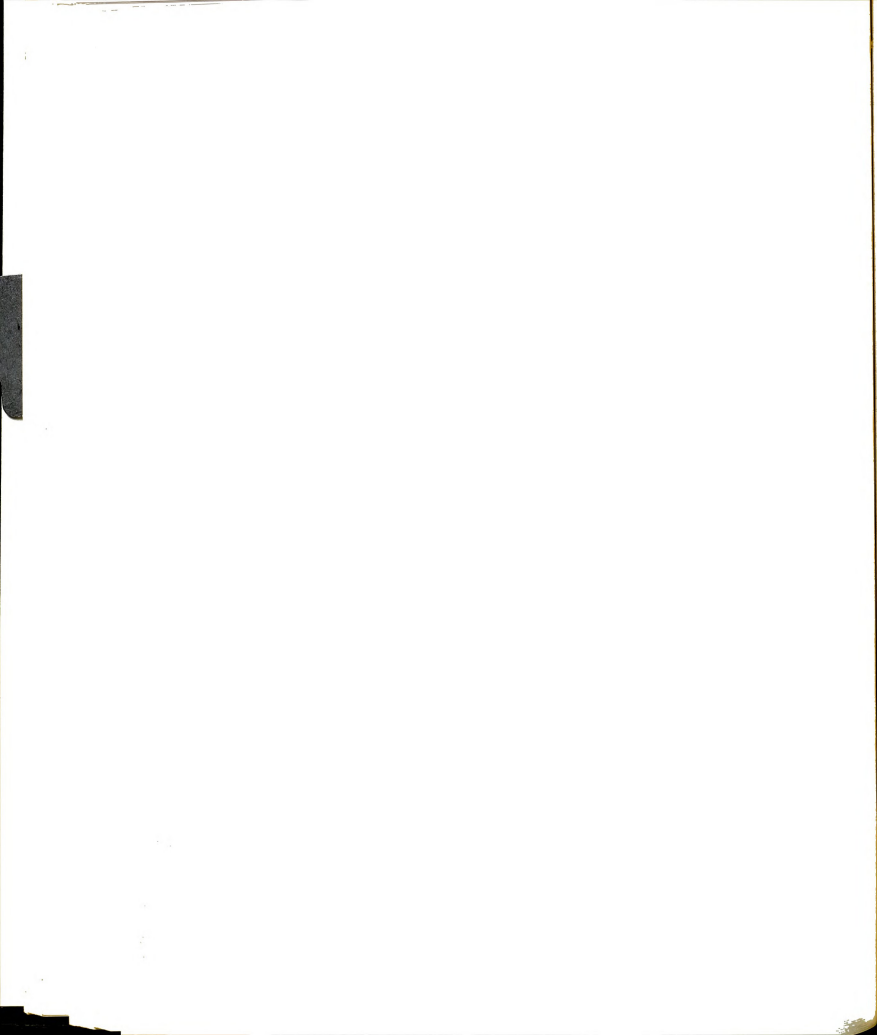
Abstract reasoning: This test indicates how well the trainee understands ideas not presented in words or numbers. Using diagrams, this test measures how easily and clearly a person can reason when problems are presented in terms of size or shape or position or quantity or other non-verbal, non-numerical forms. This test along with space relations and mechanical reasoning, helps to predict success in many kinds of mechanical, technical and skilled industrial work. Trainees who score low on Verbal Reasoning but fairly high on Abstract Reasoning indicate an ability to reason in certain ways despite a verbal shortcoming. Remedial work in vocabulary, reading and similar exercises can strengthen verbal reasoning power.

Clerical speed and accuracy: This tells a trainee how well he does paper work so important in offices, stores, warehouses and laboratories. It measures how quickly and accurately a person can compare and mark written lists such as names or numbers. It is the only test that demands fast work, and where speed in doing a simple task counts heavily. Girls tend to score higher than boys on this test.



Mechanical reasoning: This test shows how easily a trainee grasps the common principles of physics he sees in everyday life. It indicates how well he understands the laws governing simple appliances, machinery, tools and motion. Trainees who do well on this test usually like to find out how things work. They often are better than average at learning how to construct, operate or repair complicated equipment. A high mechanical reasoning score gives added evidence of aptitude in the fields of science and engineering. Men in agriculture and industry who become technicians, shop foremen, repair specialists and skilled machine operators tend to be at least average in mechanical reasoning. People who do poorly may find the work rather hard or uninteresting in shop courses and physical sciences which demand thinking and planning, rather than just skill in using their hands.

Space relations: This test measures one's ability to visualize or imagine the shape and surfaces of a finished object before it is built, just by looking at the drawings or sketches that would be used to guide workmen in building it. Trainees planning for careers not requiring college training should consider their space relations score in comparison with other aptitudes in deciding whether to look for jobs or training courses that deal with real objects--large or small, watches or tractors--rather than with people or finances, for example.



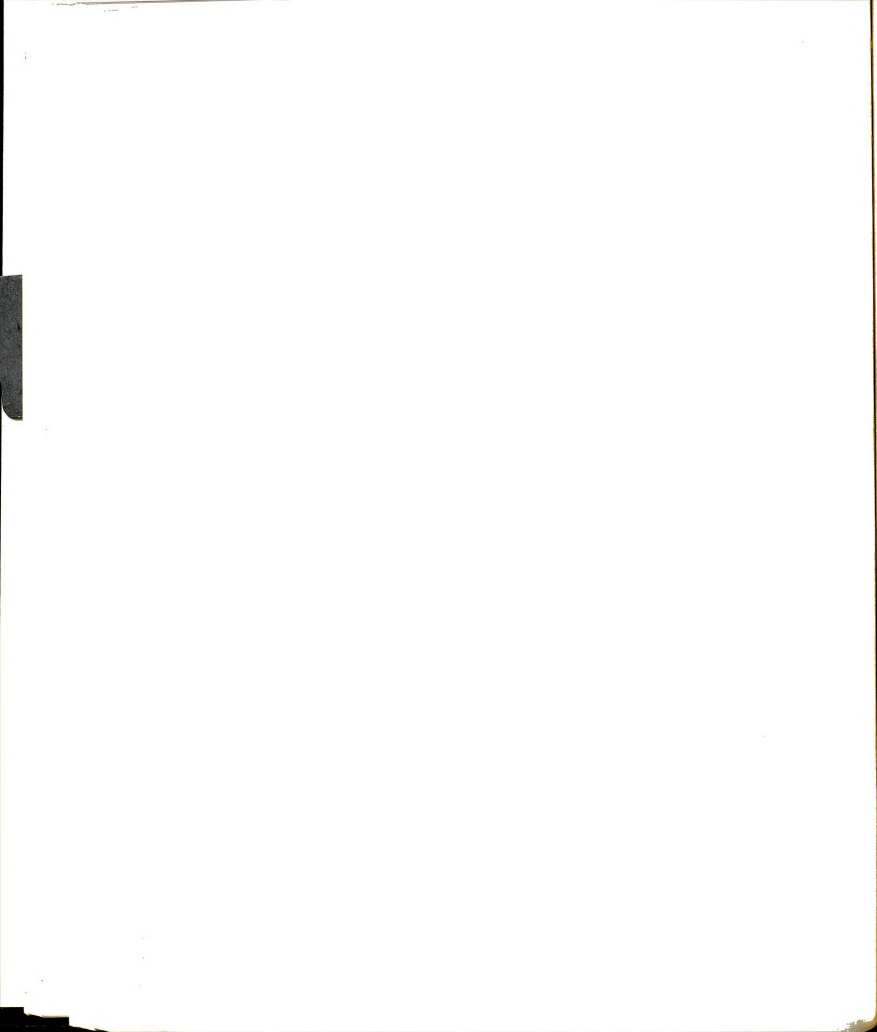
Language usage: Spelling measures how well a person can spell common English words. It is among the best predictors of ability to earn good grades in high school and academic courses.

The three most important tests for measuring the ability of low-education level trainees are the non-verbal tests on mechanical reasoning, abstract reasoning and space relations. For an example of the Mechanical Reasoning DAT Test, see Appendix B.

Pretests and Post-Tests for a Specific Course of Instruction

Establishing Pre-training Entry-Level Knowledge by Test and Interview.--The first pretest is given to trainees during the orientation lesson before they start the actual training program. During orientation they also complete a Trainee Enrollment Record. The preliminary pretest and enrollment questionnaire give the instructor an understanding of the trainee's background and form a basis for evaluating the trainee's progress at the end of training.

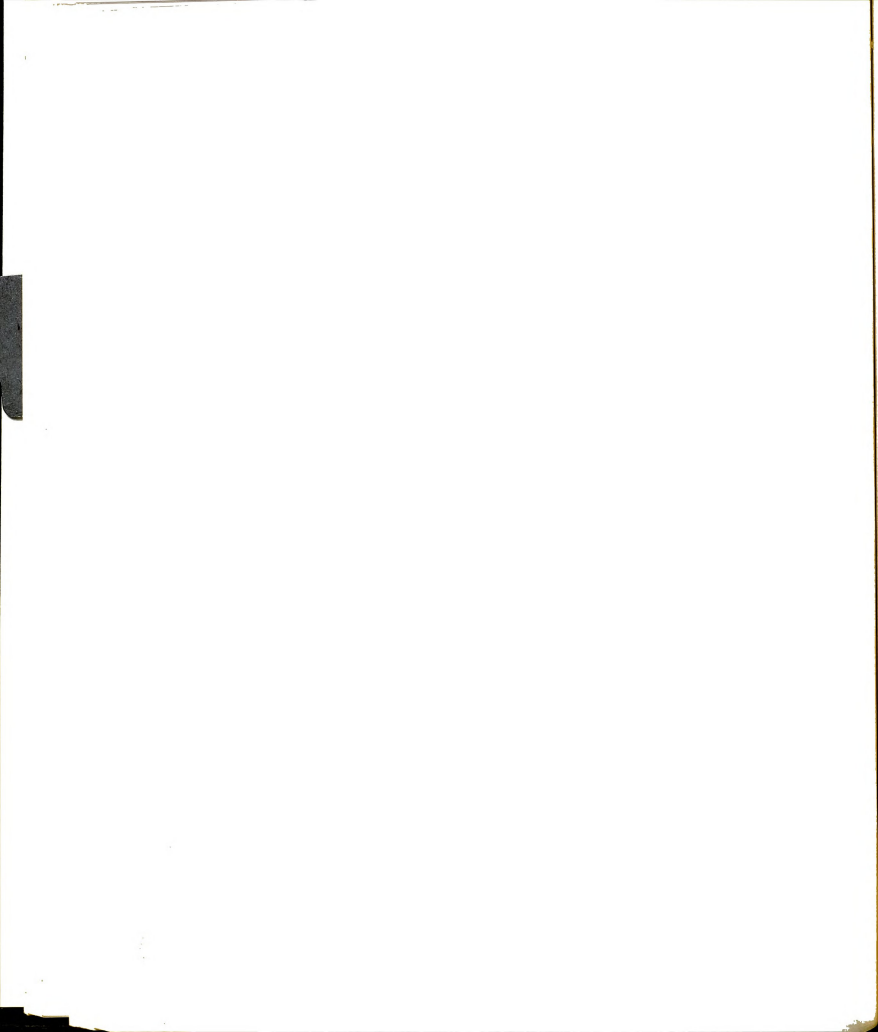
Using Individual Lesson Pretests to Determine Trainee Attitudes and Knowledge.--Prior to each succeeding lesson a short "test" is given as a pretest to all trainees to help evaluate their previous knowledge about the agricultural tractor and its associated equipment. These evaluations help to fix the trainee's entry level



for each major lesson from which progress can be measured. On an average, trainees are asked ten questions or exercises. Whenever possible, they take part in a practical exercise to demonstrate their ability and learned skills. When this is impractical because of time or the nature of the subject, the instructor asks trainees questions based on the desired behavioral objectives established for the course.

For ease in teaching and scoring the answers are put on a standardized form so the same method can be used each time. The possible answers must be carefully explained to the trainees. The trainee selects what he believes to be the "best" answer. The answer "Not Important" can be interpreted by the trainee as "This information is not important for me as a tractor operator." The answers "Don't Know," "Yes," "No," or "True," and "False" are self explanatory but must be explained to the trainees. Teaching assistants make sure their trainees mark the answer in the proper place on the answer sheet. See Page 204 in this Chapter for a sample lesson Pretest/Post-test for Lesson D-4, Selecting Transmission Gear and Range.

Administering Oral and/or Written Tests to Trainees with Low Educations.--Special instructions were prepared for using tests with low-education level trainees. These instructions to the teacher were included in the first lesson of each series in the chapter.

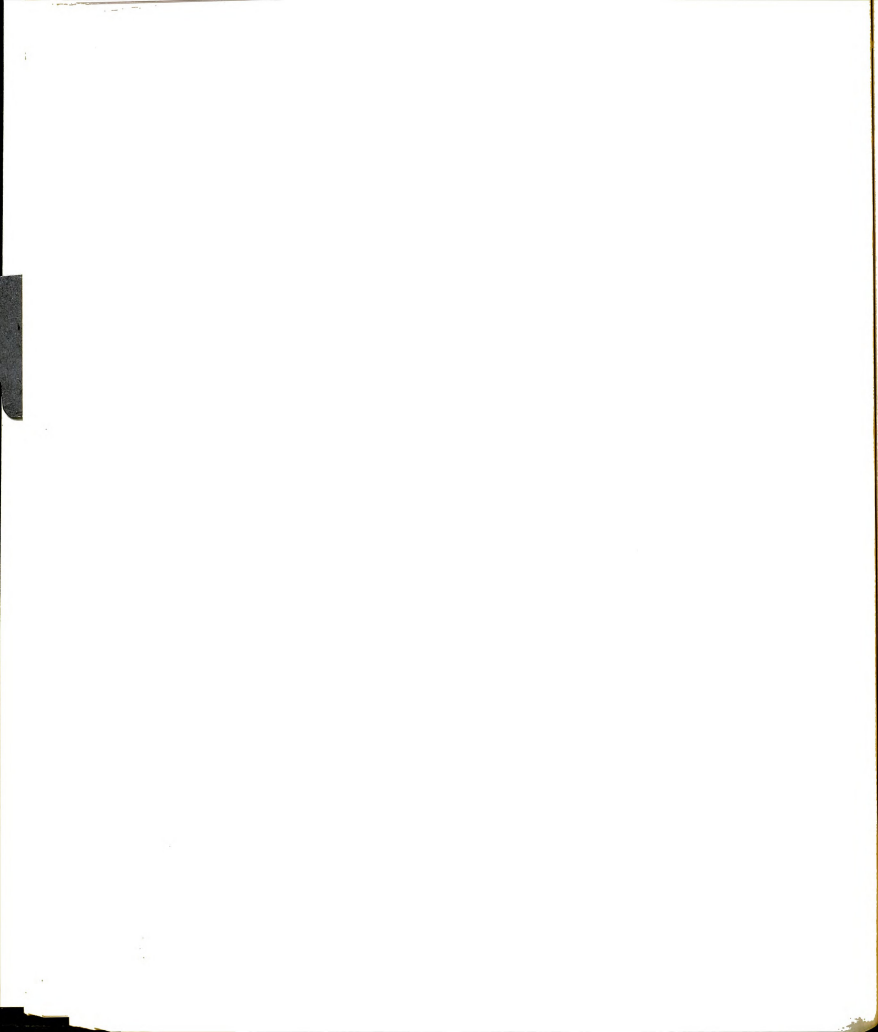


Concurrent Training Tests

Training Activities and Exercises

Small Group Activities.--The small group was designed to permit maximum freedom in individualizing course instruction. It is desirable to hold the number of trainees per instructor to a maximum of four to five to enable the small group leader or assistant instructor to work closely with each individual trainee. In carrying out the Trainee Activities discussed in Chapter III, the instructor has the opportunity to get to know each trainee individually and to discover his weaknesses and strengths. By using the guidelines given in these activities and by referring to the flow charts which accompany the majority of the lessons, he made sure that all trainees had equal opportunity to participate and to perform the various skills and exercises. The learning situations involved both laboratory and field practicals, depending upon the nature of the subject and its objectives.

As each trainee performed the skill or practical exercise the instructor observed and recorded the results, giving the trainee ample time to practice and come up to his apparent attainment level. Evaluation is part and

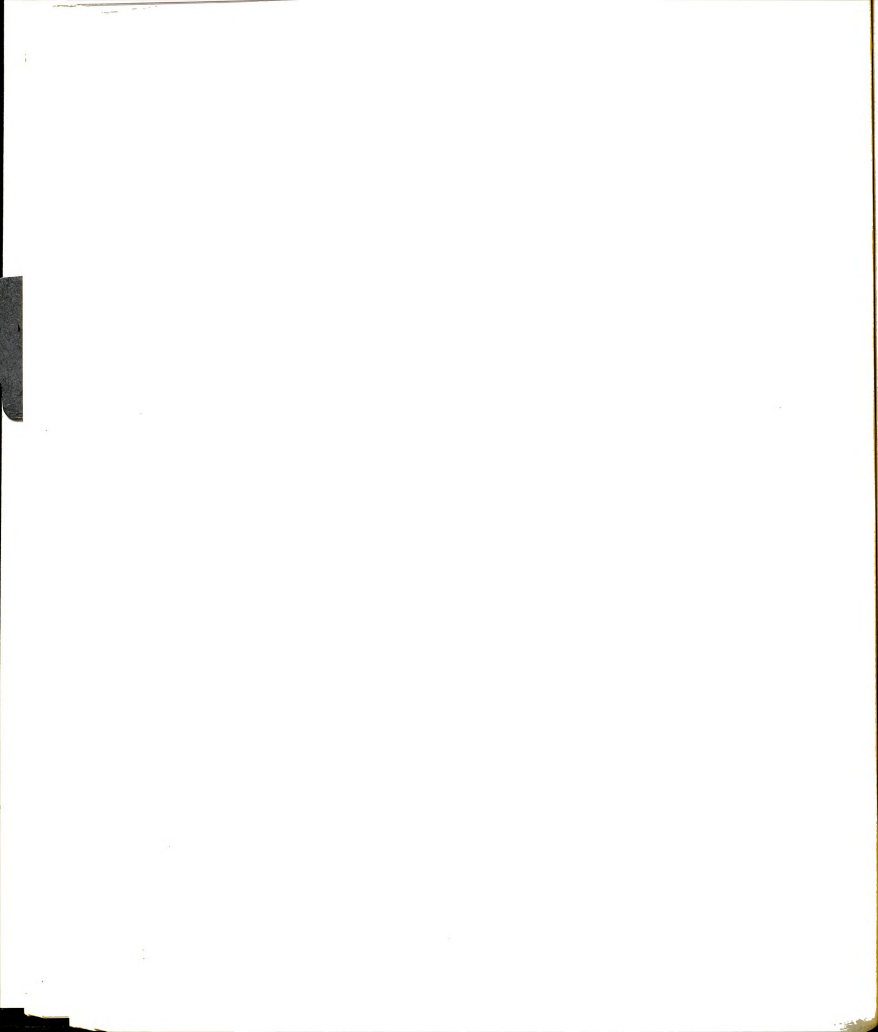


parcel of the teaching process, and as the trainee went through the learning process he was graded by the instructor for attitude, skill and knowledge (ASK).

The instructor "tested" each trainee in turn so that all were asked about the same number of questions or called upon to demonstrate a particular point or step. No one trainee was allowed to monopolize the stage nor hang back without participating. The instructor made each trainee's experiments a lesson for all the others. He kept them busy, attentive and alert by directing questions and asking for appropriate comments or "help" from them if he perceived they were losing interest or their attention was wandering. It worked very well to place one of the sharper trainees with each small group. They helped the slower members by explaining terms or by working with them, until they came up to an acceptable level of performance or knowledge.

Using Flow Charts as Instruction Guides. Lesson

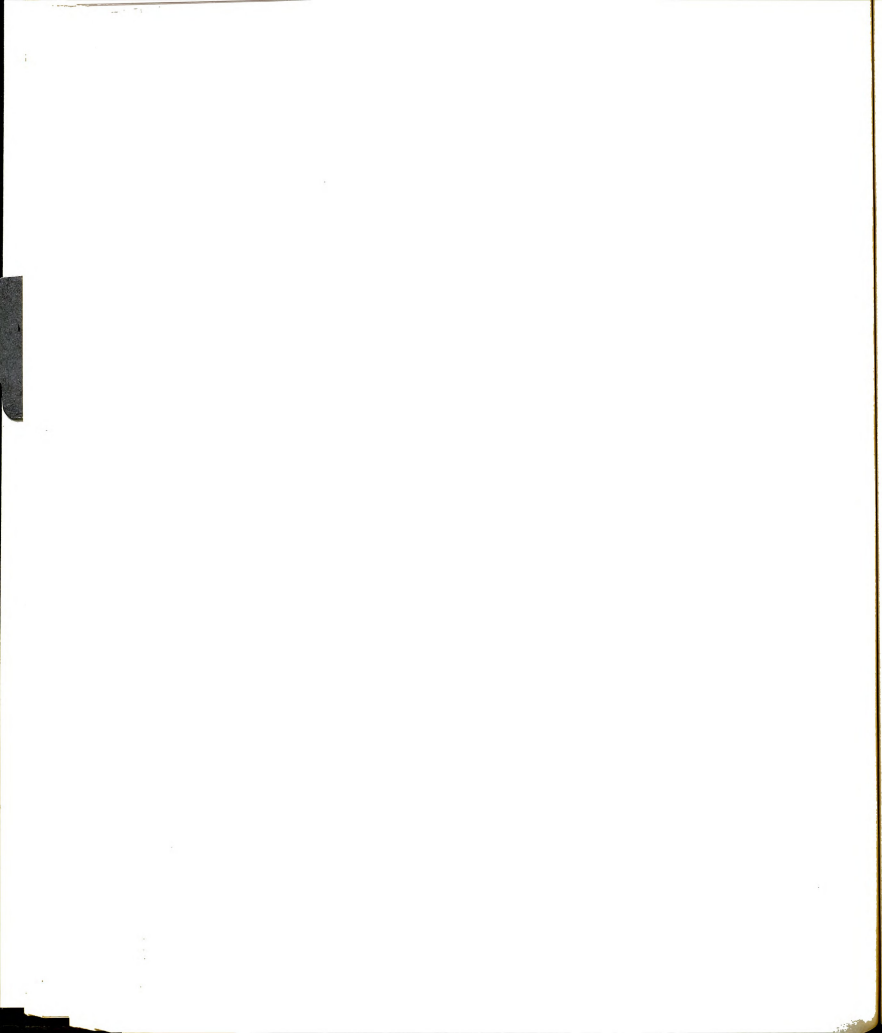
D-4: Selecting Transmission Gears.--A special type of flow chart or logic tree was devised as a training aid in teaching and testing the trainee on his skills, attitudes



and knowledge. See Figures 4.1 and 4.2 on the procedure for selecting the proper transmission gear and range on a modern diesel tractor. This flow chart was designed as an exercise to familiarize the trainee with the process of choosing the correct gear and range. It is not a procedure to be followed each time the transmission is shifted.

Flow charts are an excellent visual tool for defining an entire process. They clearly delineate the important steps and show a logical order of approach for solving any problem. Other flow charts were used to check the trainee's progress and to guide him in making the next correct step. They helped the instructor by ensuring that no step was left out and that all critical considerations were made in arriving at a decision. The flow chart identified all decisions that had to be made and the resultant follow-up to undertake.

The flow chart also indicated the kind of knowledge needed and the types of attitudes important in a process. Once the process or skill was analyzed in a flow chart it was used as a method of trouble-shooting or evaluation. As a logical order of action it was a blueprint for systematic problem solving. While the flow charts were designed for the use of the instructor to improve his teaching, they can also be used by literate trainees to



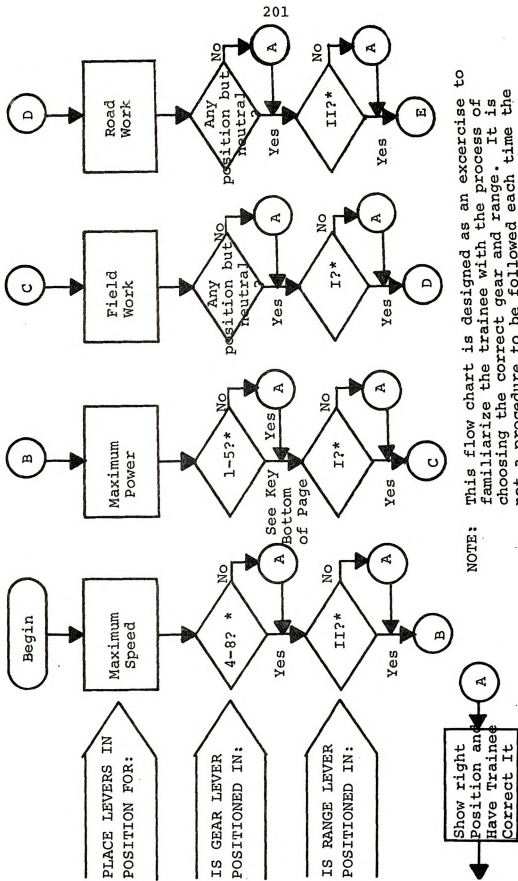
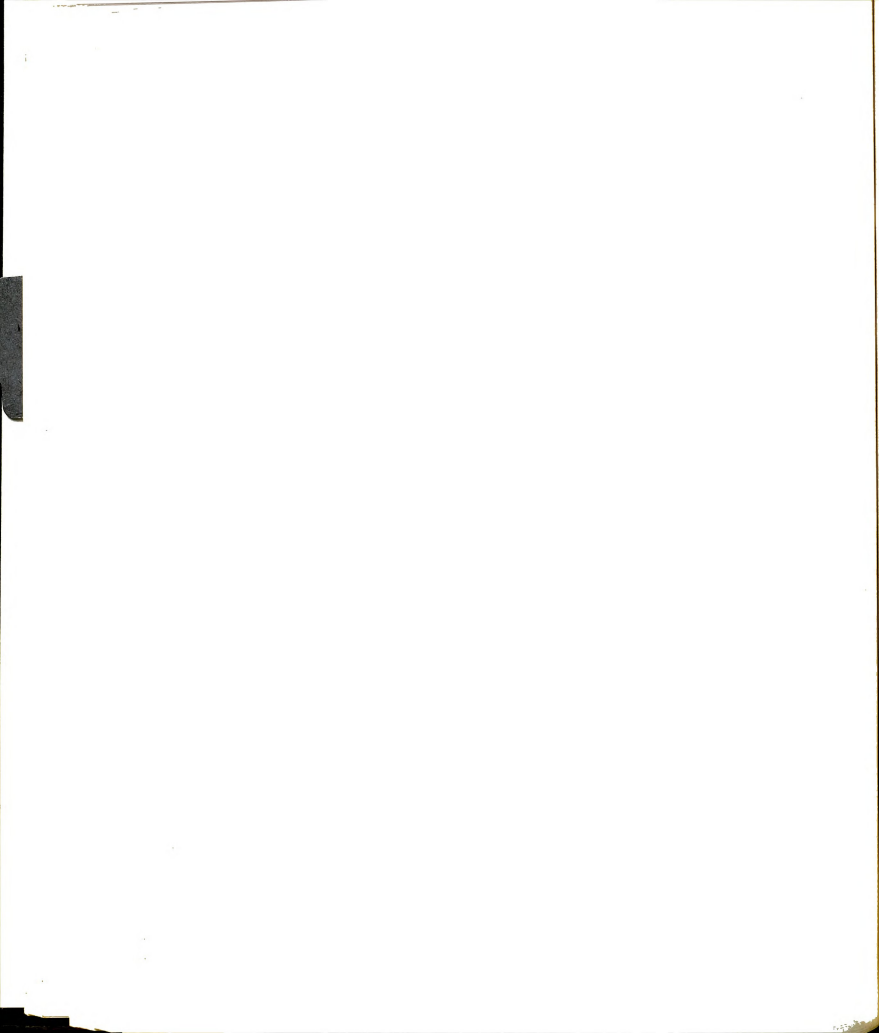


Figure 4.1.--Flow Chart for Lesson D-4: Selecting Best Transmission Gear and Range Combination. (Page 1 of 2)



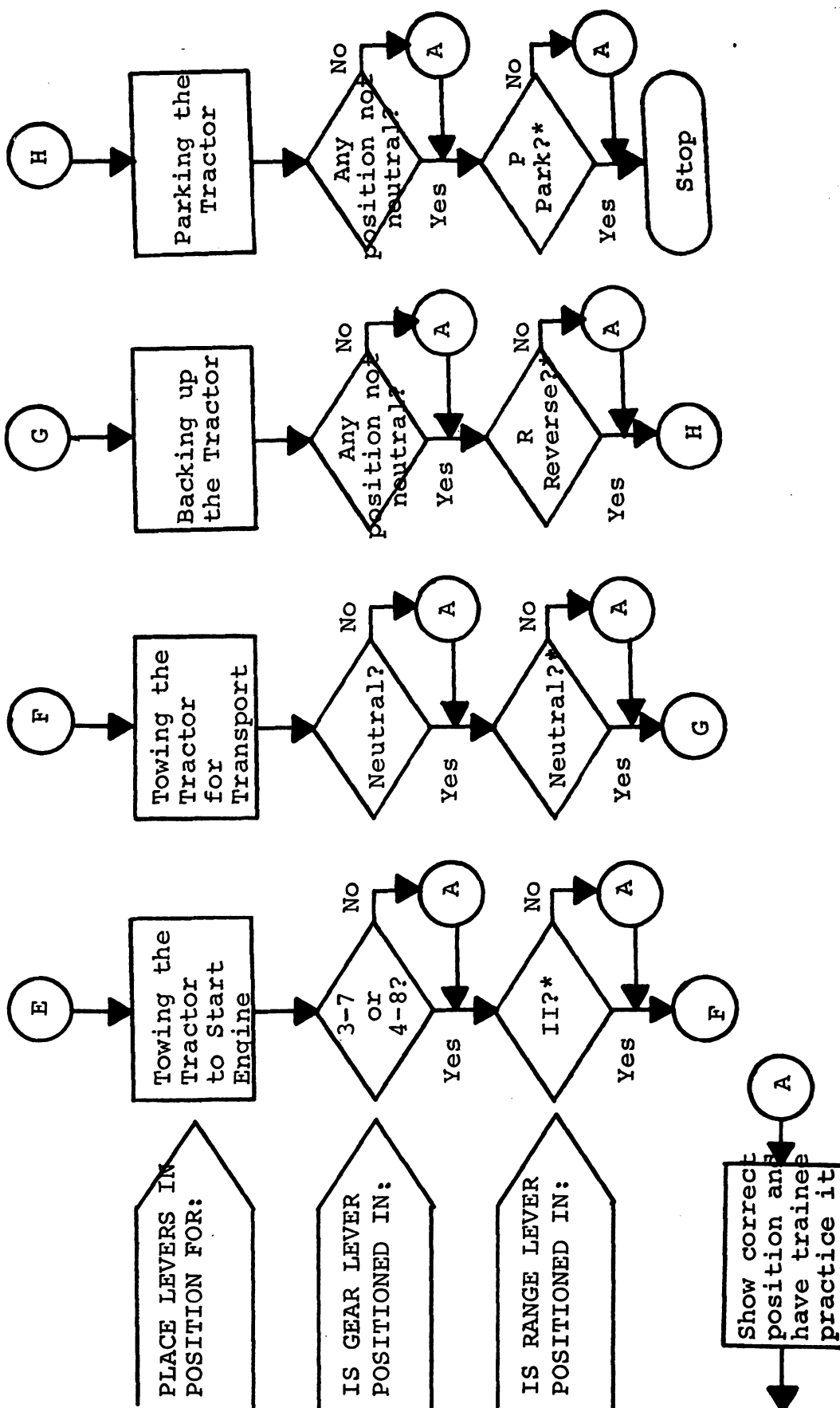
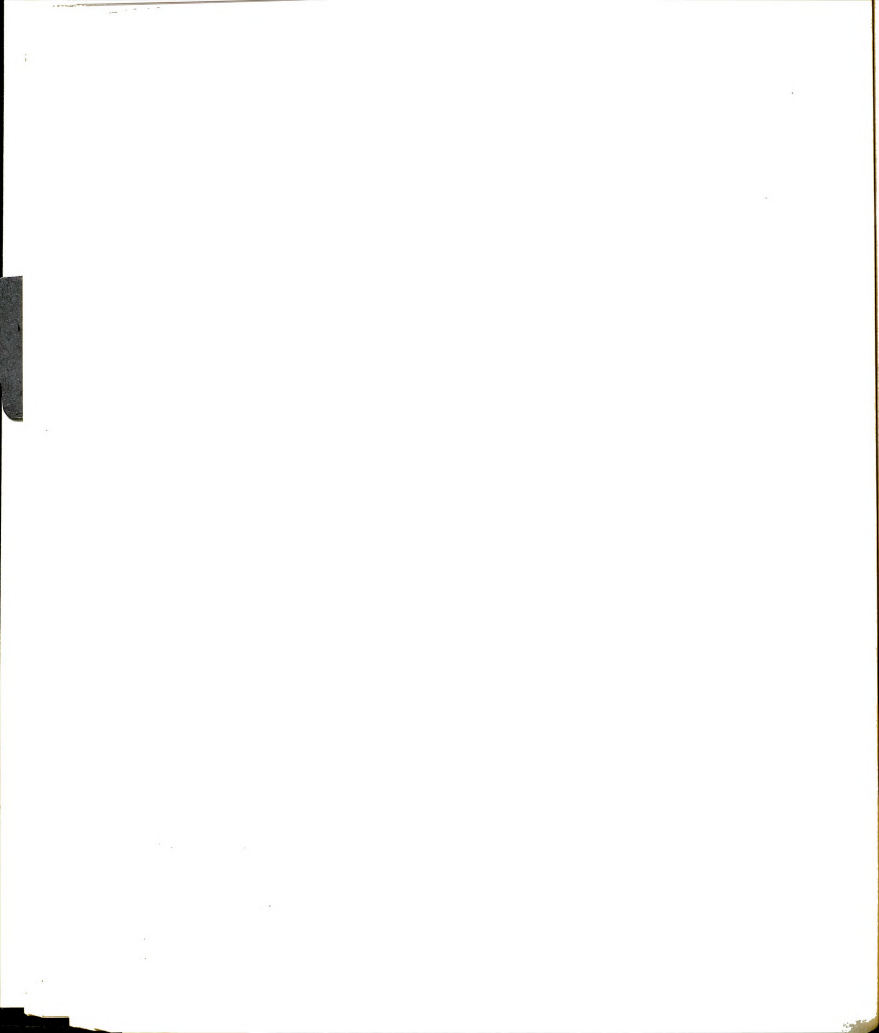


Figure 4.2.--Flow Chart for Lesson D-4: Selecting Best Transmission Gear and Range Combination. (Page 2 of 2)

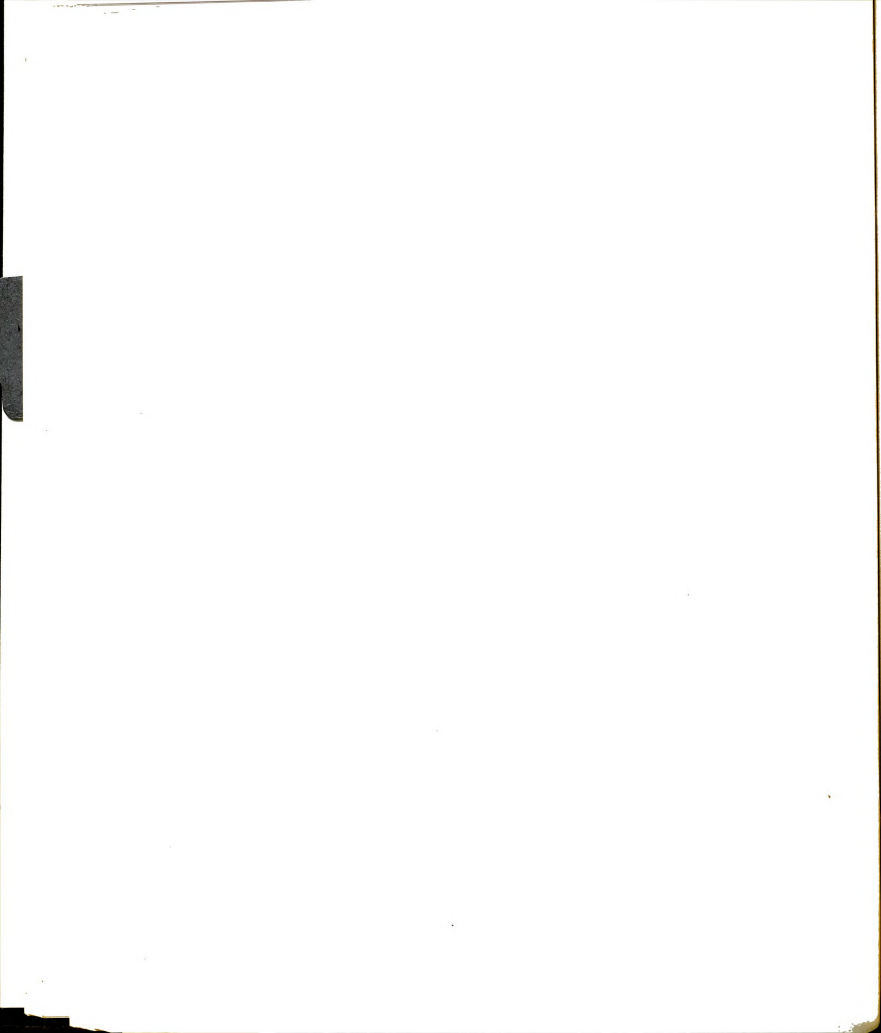


help them do their tasks more efficiently and effectively without back-tracking or repeating. See also Figures 3.5 and 3.6 in Chapter III for other examples of flow charts.

Lesson Evaluation and Post-test: Revised Post-test Stated as Questions.--During the main presentation by the chief instructor to the large group, and during the laboratory work period in the small groups, the trainees were further evaluated and checked by each group leader or teaching aide. Using the "teaching checklist" under "Trainee Activities" at the end of each lesson, the trainees took the same pretest a second time as a post-test to see if they had learned the key points. If time permitted the small group instructor made up additional questions or exercises to test the practical application of knowledge and skills presented in the lesson. By reviewing the results of the pretests and post-tests, the instructor pinpointed the weak points and the areas needing further clarification.

An example of a revised pretest/post-test stated as questions with a "Yes," "No," or "Don't Know" answers is illustrated on page 204 for Lesson D-4 on selecting the transmission gear and range.

Keeping the 1,000-Hour Tractor Service Record.--For the illiterate operator, a 1,000-hour service record was made on heavy paper similar to the model in Appendix C labeled UM-1. This form was designed after one made by



SAMPLE LESSON D-4: SELECTING TRANSMISSION GEAR AND RANGE
TRAINING EVALUATION NO. 39

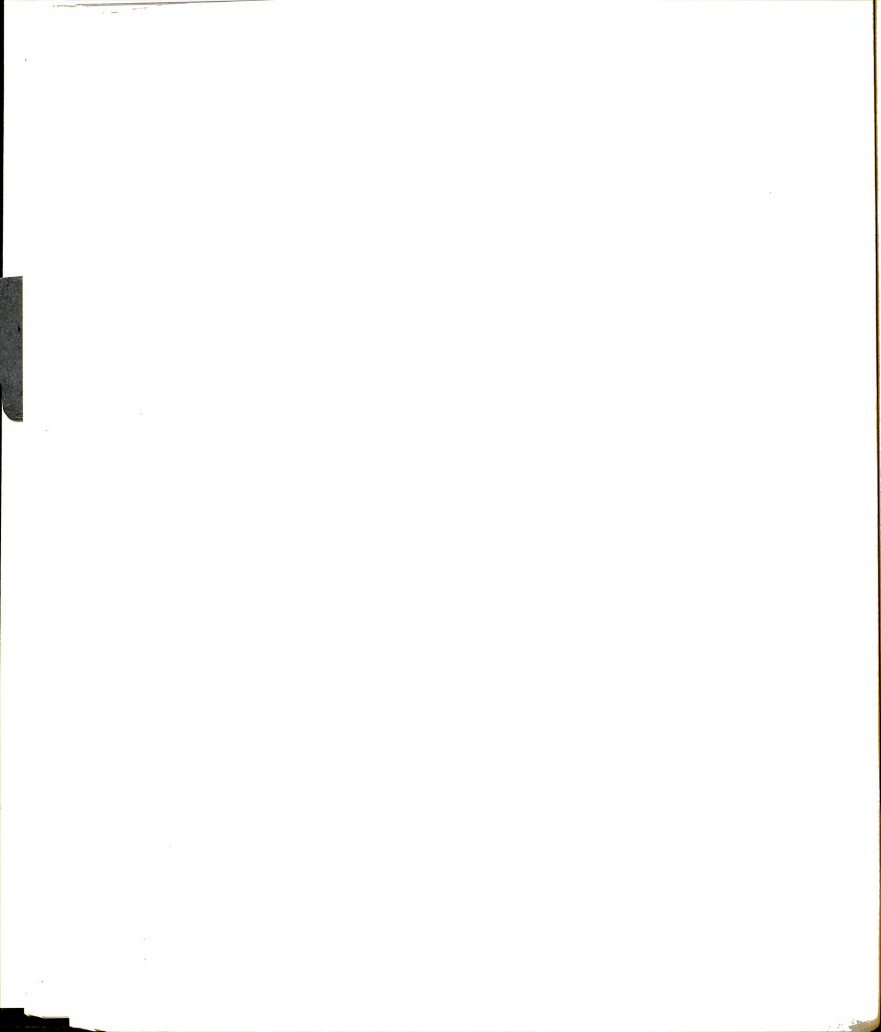
204

Pretest _____ Post-test _____
Score 1 _____ Score 2 _____

Date _____
Trainee _____

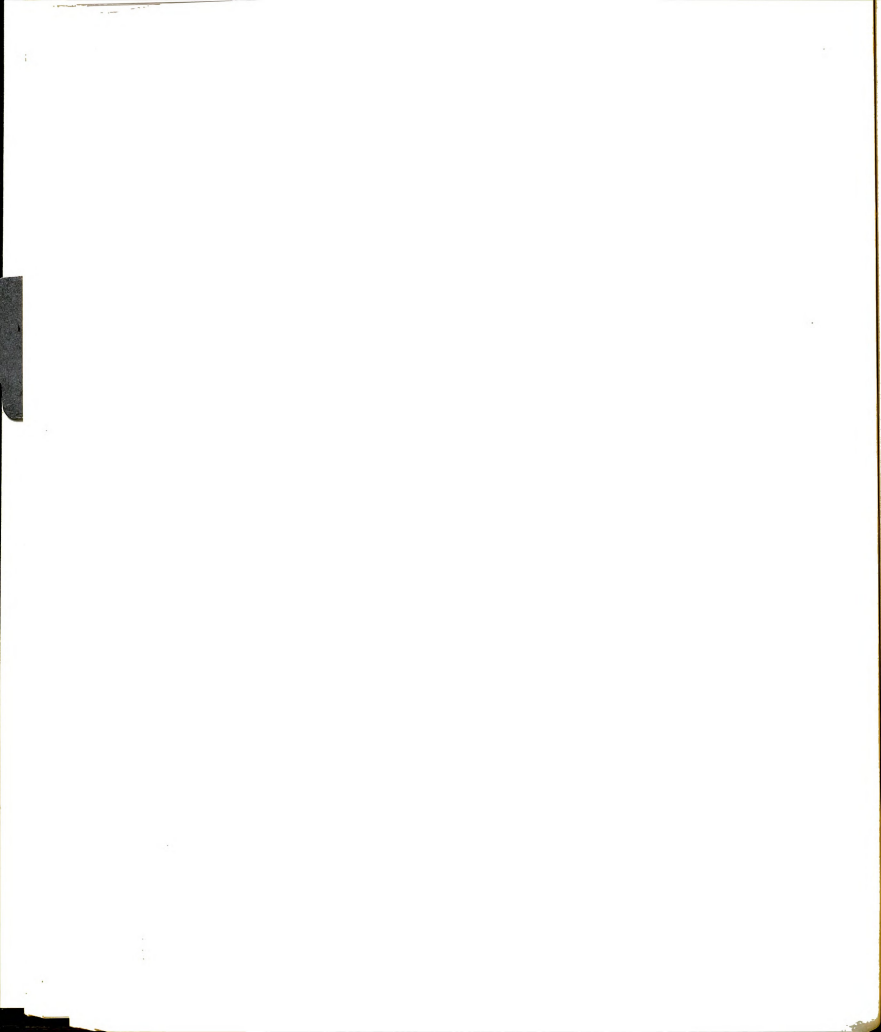
SEE "INSTRUCTIONS TO TEACHER, ASSISTANTS, AND TRAINEES" LESSON D-1

	Don't Know	Yes	No
1. Is the position "I" for the range lever used to give fast forward speeds for the tractor?	_____	_____	_____
2. Are the fast forward speeds for the gear lever identified by the right hand number of each pair, such as 3-7?	_____	_____	_____
3. On the John Deere tractor must the transmission first be shifted into the desired range before it can be shifted into gear?	_____	_____	_____
4. Must the operator use the Owners Manual to determine the ground travel speeds for each gear and engine speed?	_____	_____	_____
5. Should both transmission levers be placed in neutral to tow the tractor?	_____	_____	_____
6. In an emergency can the diesel tractor be started by towing?	_____	_____	_____
7. In towing it it permissible to pull the tractor at speeds up to 30 mph?	_____	_____	_____
8. If the tractor is equipped with a multiple-speed or quick-shift transmission, such as the John Deere Hi-Lo shift, is it permissible to tow the tractor to start the engine?	_____	_____	_____
9. Does one gear always give the best combination of speed and power for field work?	_____	_____	_____
10. Are the basic gears for field work 1, 2, 3, 4, and sometimes 5 on an 8-speed transmission?	_____	_____	_____



Bartlett so that the uneducated operator merely looks at his tractor speed-hour meter and matches the number he sees in the middle of the dial with the same number on the chart (George Bartlett, 1966, pp. 6-10). At the end of each day he circles this number on the 1,000-hour chart. Each time the circled number is close to, or within, a red color-marked column, he knows that his tractor needs to be given the lubrication and maintenance services pictured on the daily maintenance guide chart for the "A" (red) or 10-hour service. See Appendix C.

Ideally the operator should stop and service the tractor whenever the hour meter reads any multiple of 10 hours; but in order to form good habits of regular service, it was desirable to perform certain services at the beginning and end of every work day. Each time the circled number reached a green, yellow or orange square on the right hand side of the chart, the operator knew that the tractor had to be given additional service. Again, the pictorial maintenance guide gave a quick reference to the required "B" (green) 50-hour maintenance services to be performed weekly by the operator. At this time he also assisted the mechanic in doing all of the services called for by the yellow- and orange-colored boxes containing the "C" and "D" services numbered 250, 500, 750 and 1,000 hours as recorded by the tractor hour meter.

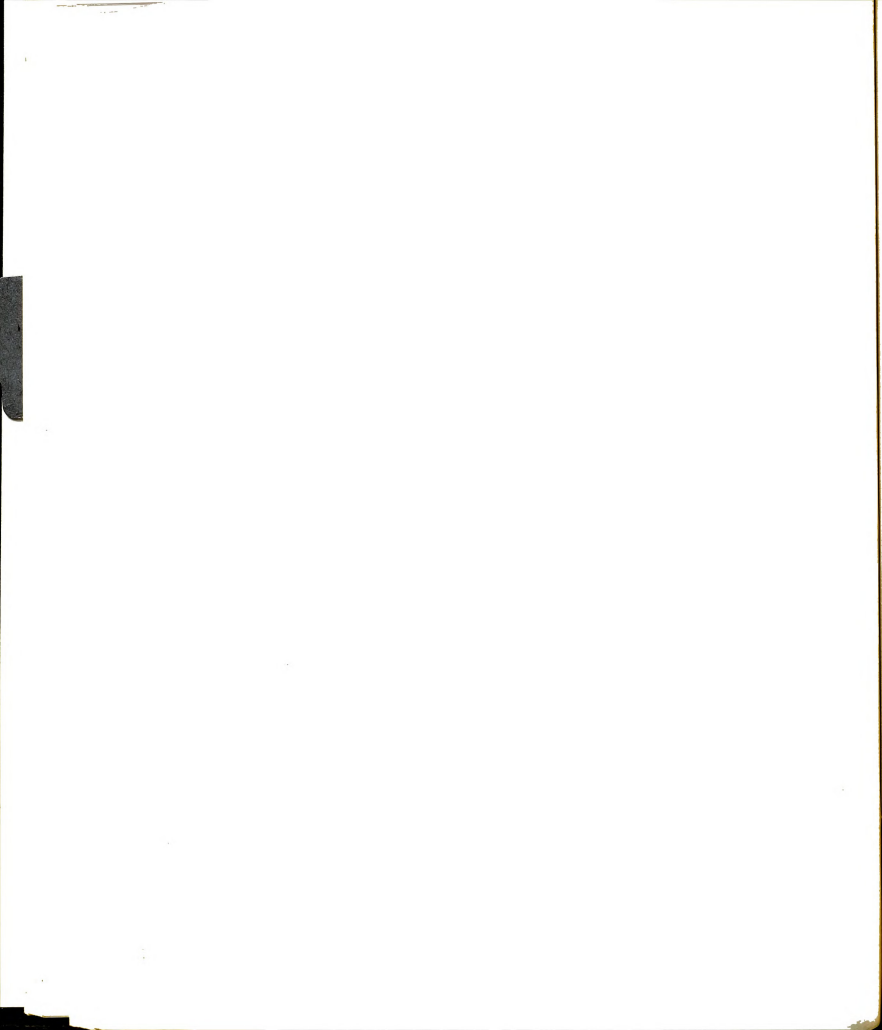


For the literate operator, a simpler chart marked UM-2 was developed with only key numbers in the column headings (see Appendix C). The operator counts the spaces and checks the proper box at the end of each day. Each time the A service is performed, he initials the box. At the 50-hour intervals he also initials the B, C, or D boxes as required and assists the mechanic in performing the C and D services called for as shown on the Maintenance Guide for the 250,500, 750 and 1,000-hour periods.

Using the Pictorial Maintenance Charts.--The daily maintenance services are pictured on a Pictorial "A" Daily (10-hour) Maintenance Guide Chart Form UM-3. The operator service checks were listed in a logical systems order in two columns from top to bottom. Each picture was numbered in sequence and color-keyed in red to indicate it is a service to be performed daily. A brief statement below each picture indicated the service to be carried out (see Appendix C).

The weekly maintenance services are illustrated on a Pictorial "B" Weekly (50-hour) Maintenance Guide Chart, Form UM-4 (Appendix C). In the same manner it was color-keyed in green to indicate that it corresponded to the green boxes on the 1,000-hour tractor Service Record.

Trainee Daily Training Evaluation (Form EV-2).--Assessing trainee progress requires daily evaluation of each trainee, lesson by lesson. A form called the "Trainee

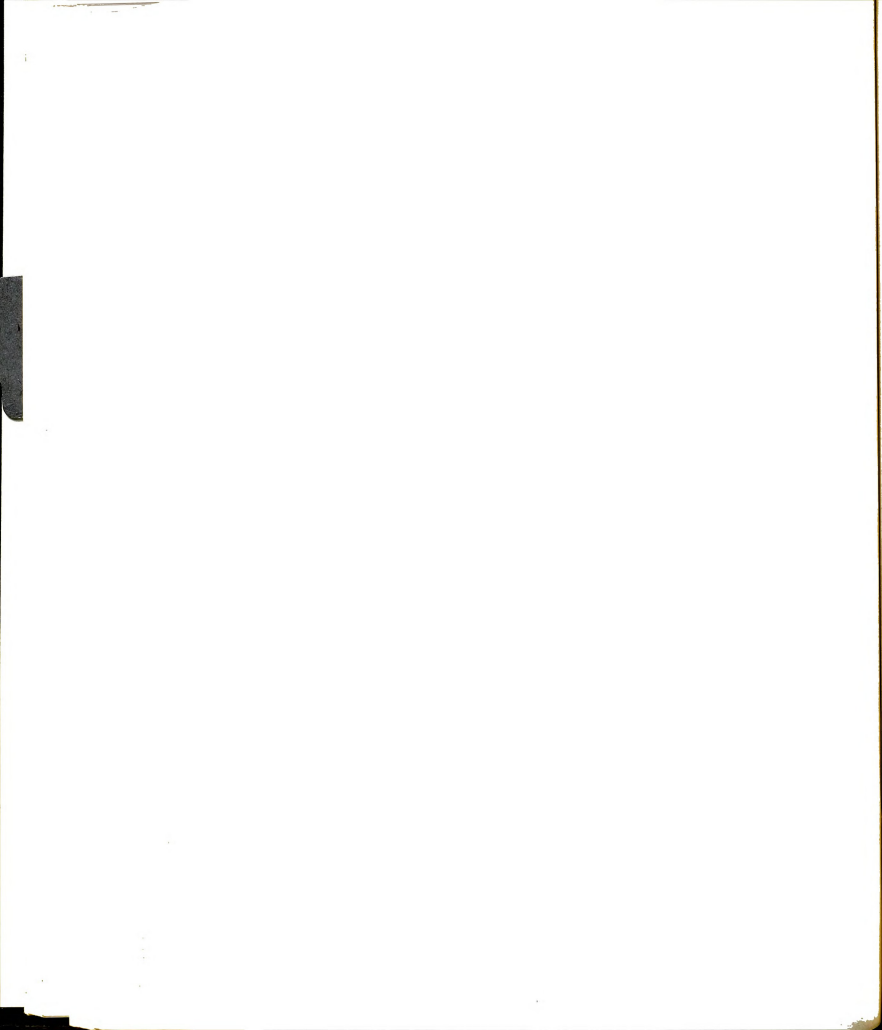


Daily Training Evaluation" was provided for tabulating this information (see Appendix C). If this information is accurately kept, the instructor can individualize the course so that every trainee will be kept up-to-date and successfully complete all course requirements. Wherever deficiencies were noted, special efforts were made to review that trainee before he got so far behind that he was unable to make up his deficiencies.

The Daily Training Evaluation form worksheet was designed to be used by the instructor to keep a running record of each trainee in the small group sessions. Space was provided for each trainee's name under each lesson. The daily rating for attitudes (A), skills (S), and knowledge (K) was made at the end of each lesson session. The data from this form were transferred to Form EV-4, the permanent record for each trainee.

Rating Trainee Attitudes, Skills and Knowledge
(ASK).--

1. Attitude (A): Because the attitude of the trainee played a critical role in his success or failure as a tractor operator, it was necessary to attain some measure of his attitudes while in training. When attitude rating was taken daily a fairly accurate picture became apparent by the end of the training period. In making judgments about attitudes, the instructor was careful not to let previous work or attitudes of the trainee influence



the current evaluation. The trainees were rated according to the following scale:

+ = Positive

- = Negative

0 = Neutral

Following is a list of suggested criteria for making judgments concerning attitudes. These criteria are used by Bartlett (p. 10) with the South African Sugar Association.

<u>Plus (+)</u>	<u>Minus (-)</u>
1. Interested	Not interested
2. Methodical	Unmethodical
3. Energetic	Makes little effort
4. Calm	Nervous
5. Keen	Bored
6. Steady	Variable
7. Cautious	Impulsive
8. Relaxed	Tense
9. Controlled	Confused
10. Attentive	Inattentive

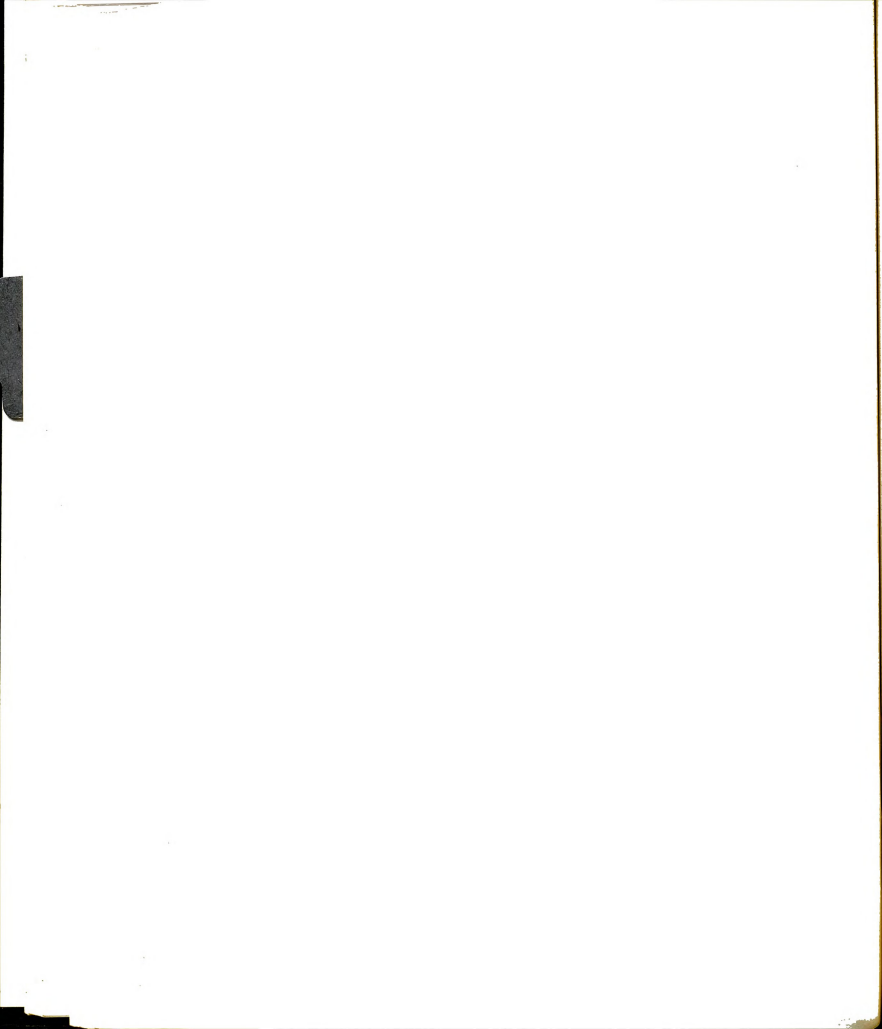
When it was not possible to make any deductions concerning attitude, a "0" for neutral was given as the evaluation mark.

2. Skills (S) and Knowledge (K): Most students did better when they were learning skills rather than the more theoretical aspects of the training program. Since lessons vary in the proportion they involve skills or knowledge, space was provided to make a judgment for each. The trainees were graded from 0 to 3 as follows:

0 = Unqualified. Trainee knows less than 80

per cent of the starred (*) items. He

needs considerably more review and retesting.

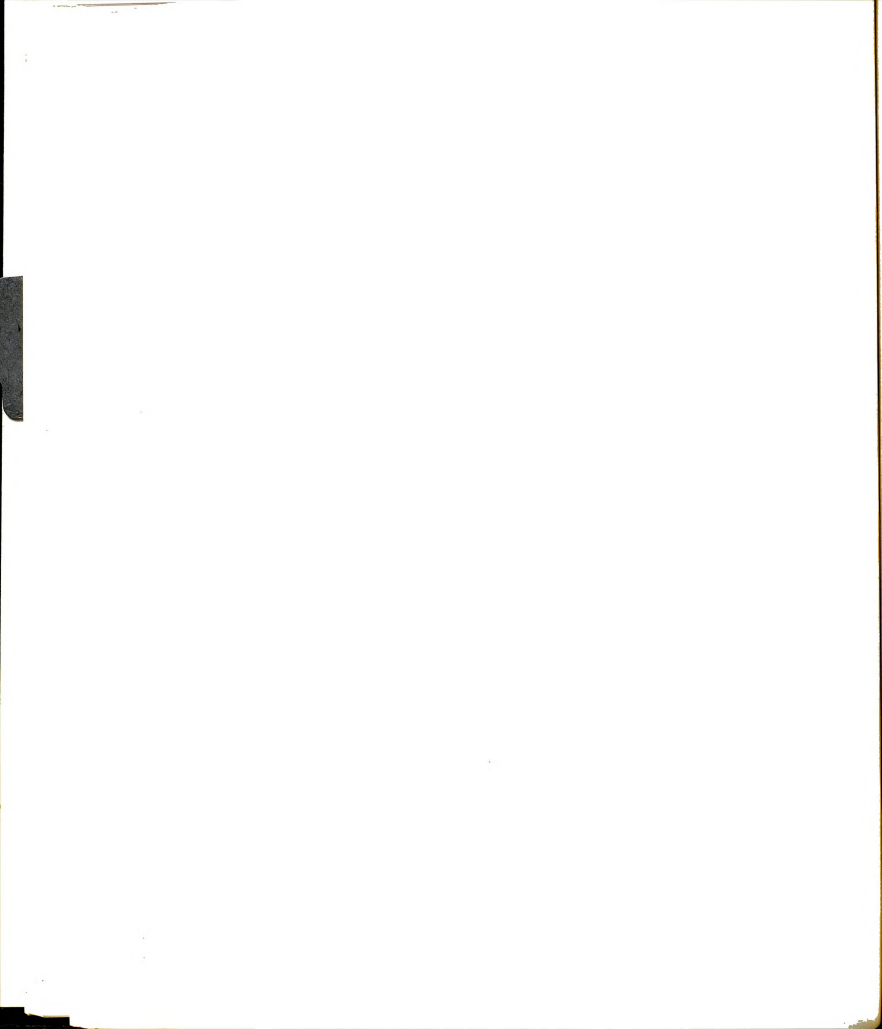


- 1 = Needs more work. Trainee missed from 1 to 20 per cent of the starred (*) items. A little more review and retesting on the missed points will qualify him.
- 2 = Qualified. Trainee knows all or 100 per cent of the starred (*) items. He receives a passing rating.
- 3 = Superior. The trainee knows all starred (*) items and at least 80 per cent of the unstarred or nice to know items.

This rating scale was placed at the bottom of the evaluation sheet for convenient reference by the instructor.

3. Checkpoints: The instructor recorded the correct and incorrect checkpoints in the appropriate column of the Trainee Daily Training Evaluation form according to the method described previously under the use of the activity sheets (see Figure 3.9, page 168).

The remainder of the evaluation sheet was devoted to space for recording each trainees' scores on the pre- and post-tests as well as a space for any pertinent remarks about his progress. If the decision was made to review each starred item with each trainee for a final evaluation, the appropriate spaces under "Final Rating" were used. This facilitated quick comparison of the trainee's performance during the small group sessions and in the final evaluation.



Evaluating Each Trainee and Keeping a Daily

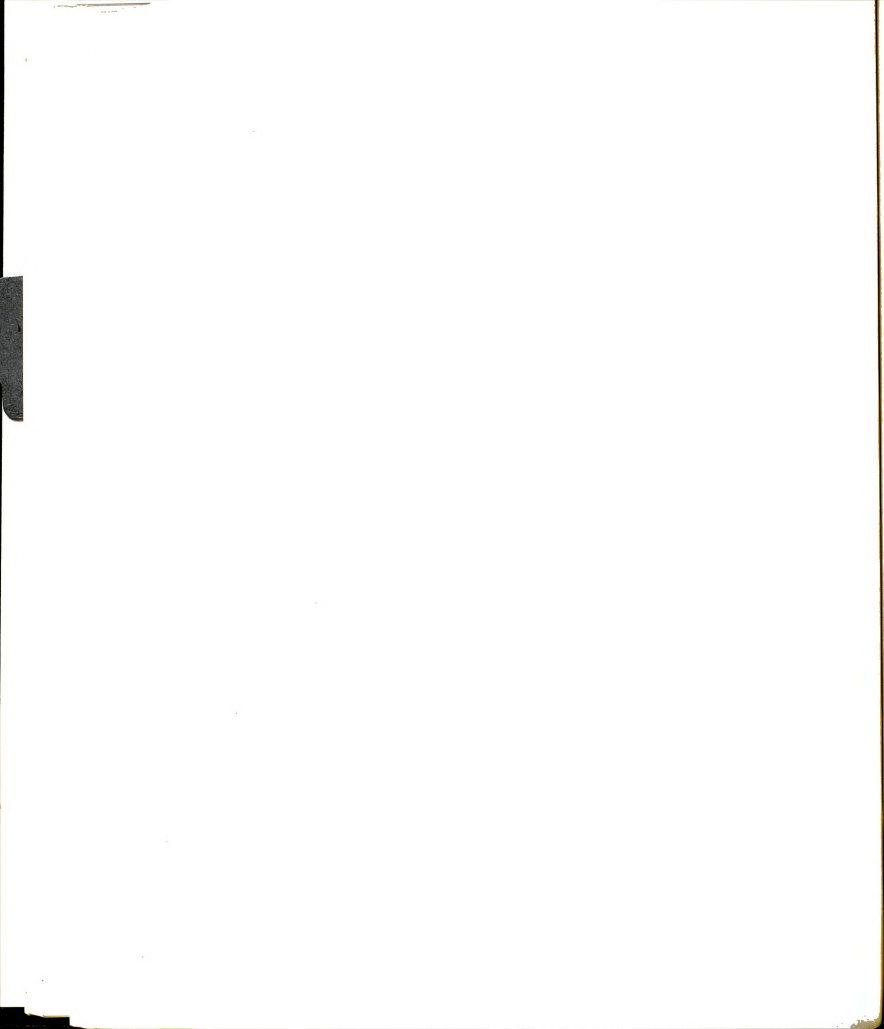
Progress Record.--At the end of each day, the instructor and his teaching assistants evaluated each trainee on all lessons covered that day. These marks were recorded on special Trainee Daily Evaluation Forms by each instructor for his group of trainees. Each trainee was asked a representative number of questions and his answers to specific behavioral objective checklist questions were recorded as correct or incorrect. The instructor used this as a basis for assigning a weighted value for "Attitudes," "Skills" and "Knowledge" (ASK) upon the completion of each lesson. This same process was followed for all lessons in the course.

By observing each trainee daily in a small group, by having a daily recorded evaluation on each trainee's performance and by comparing the pretest and post-test scores on the training evaluation, the instructor had an up-to-date and meaningful check on each trainee's progress. The daily evaluation form also showed where the trainee was weak and which topics in each lesson needed more attention to bring him up to the desired training standards.

Daily Reviews and Evaluation Rating

Instructor's Daily Lesson Evaluation (Form EV-3).--

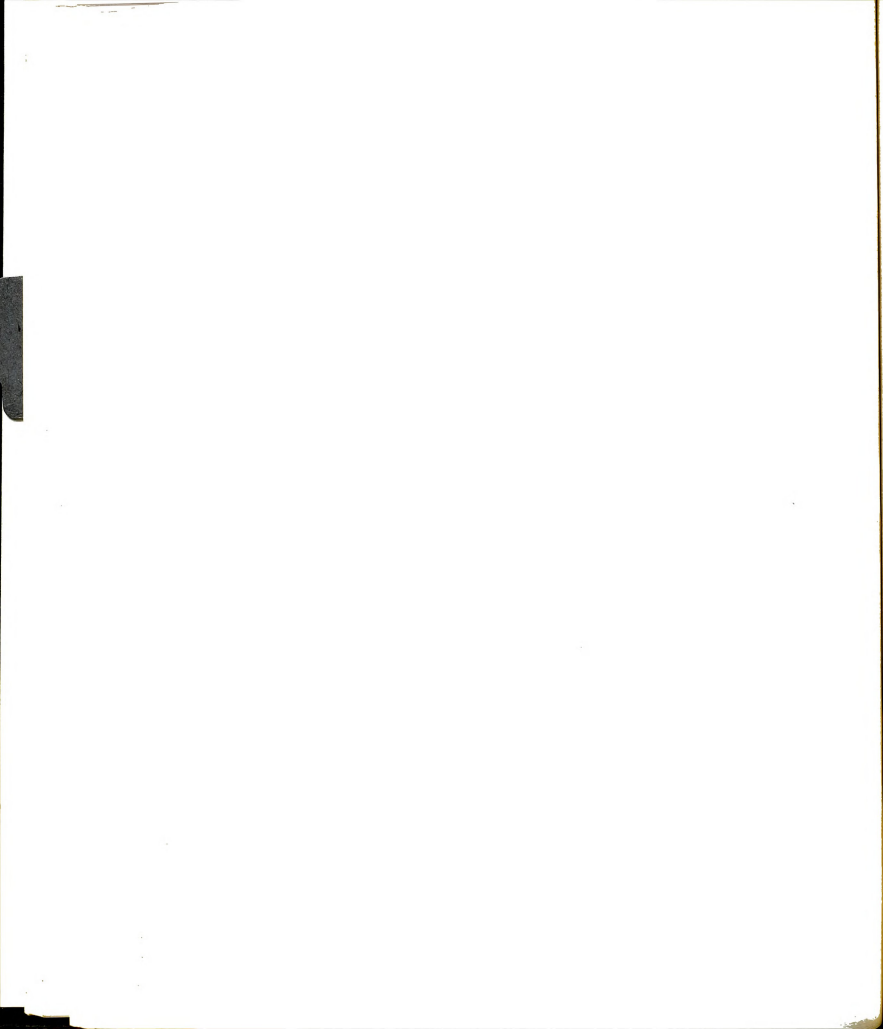
This form was designed to encourage the instructor to



carry out self evaluation of his teaching techniques and of the course instructional objectives (see Appendix C). By promptly writing down his assessment of the days activities, what was good and what could be improved, he had a source of feedback to reinforce his realization of better teaching. Without taking this step or making a sincere effort to change, most such good intentions would soon be forgotten or excused as being unimportant. Not only must the instructor continuously evaluate and critically review the progress of each trainee, but he must assess the quality of the learning environment for which he, the instructor, is responsible.

During the preliminary test and trial run all instructors were asked to help weed out the "bugs" by making constructive criticisms. They were to challenge any items that should be changed, left out or added-to make it easier for the instructor to teach or the trainee to learn. Special attention was given to suggestions on how to improve instructional methods, techniques, training aids and evaluations. They were to note each item that worked especially well and to explain why anything else did not do the job expected of it.

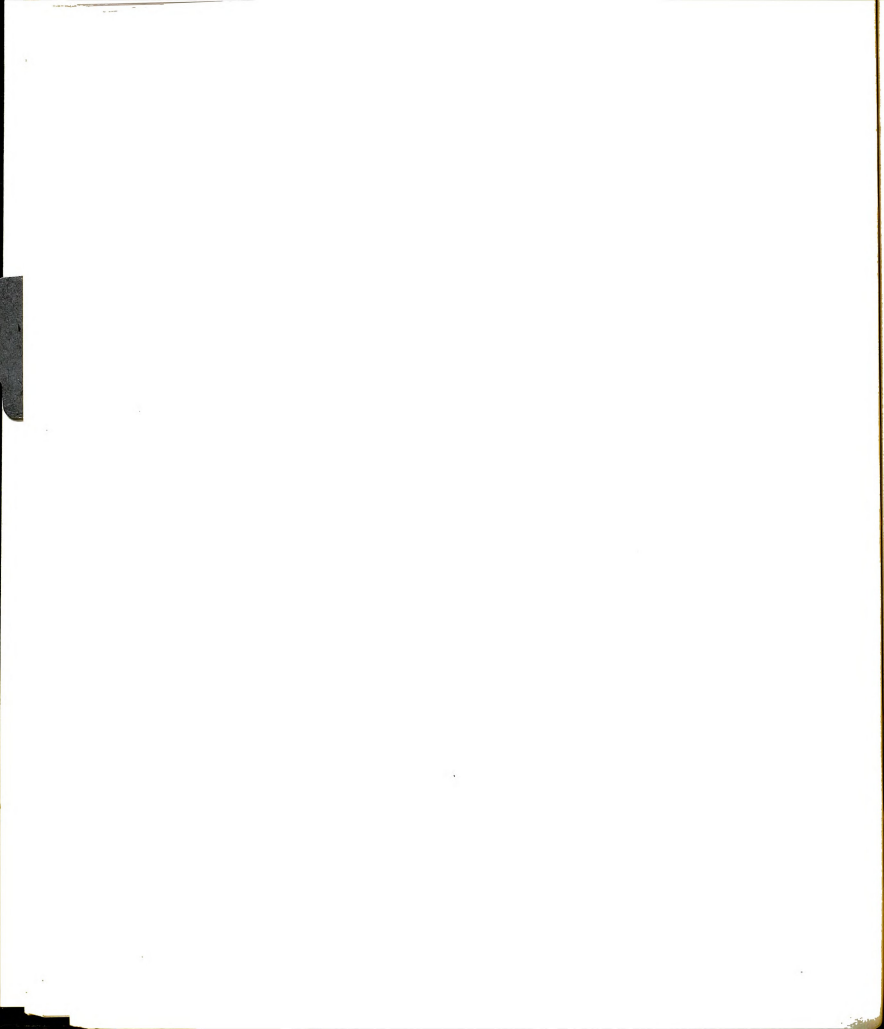
When the training program was set up on a half-time basis, the instructor's Daily Evaluation form and the Trainee's Daily Evaluation Form were to be filled out for each four hours, or half day, of instruction. For a



full-time training program lasting three to four weeks, the evaluations were made at the end of each day.

Noting Deficiencies and Grading Each Trainee.--The Trainee's Daily Training Evaluation, Form EV-2, was designed to be used with any lesson with any trainee. For ease in keeping track of the overall progress of each trainee, space was provided to record test scores for each trainee as well as to give him an individual rating on his ASK accomplishments for each lesson. The instructor made notes on individual trainees as he saw the need.

In evaluating each trainee, the instructor emphasized success rather than failure. But, at the same time it was redundant to mark down only the things the trainee gets right. While looking for strength in the trainee, the instructor at the same time looks for weakness in his teaching. After he felt the trainees had reached their optimum training achievement, based on their entry knowledge level, their apparent capability and the amount of time allowed for the lesson, the instructor tested all trainees as extensively as possible. If he knew that a trainee "knew" the answer, it was pointless to ask him to repeat it. It was more valuable to ask someone who "may not know it" to reinforce his learning process and drive the point home. The good instructor selectively asked the trainees to perform or to explain some point in

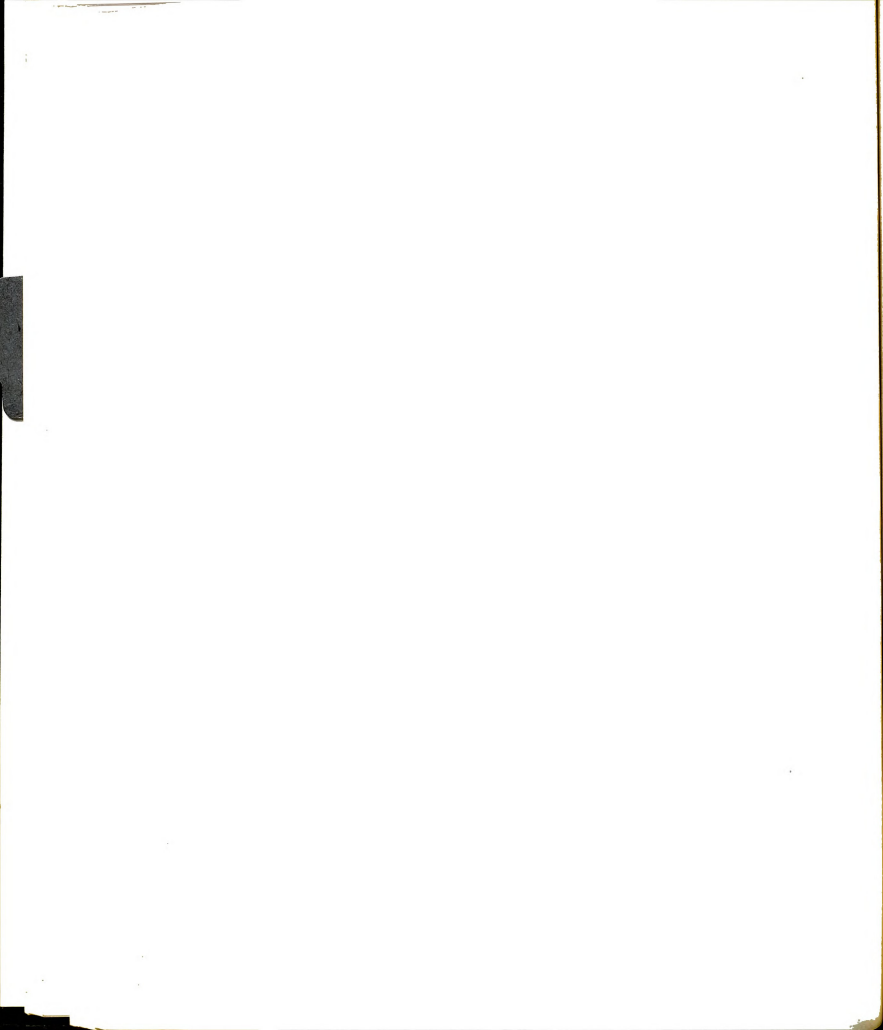


order to maximize learning and to reinforce its retention through meaningful repetition.

Making a Composite Evaluation of ASK.--In making the individual lesson and daily evaluation on each trainee, the instructor concentrated only on how and what the trainee did for a particular lesson or a specific situation. He studiously avoided being influenced by what happened yesterday or the lesson previously. If this is done the record will reflect the trainee's real progress much more accurately. The sum total of all assessments for attitude then indicated a change in attitude as well as the type of attitude. This is likewise true for skill and knowledge development and attainment.

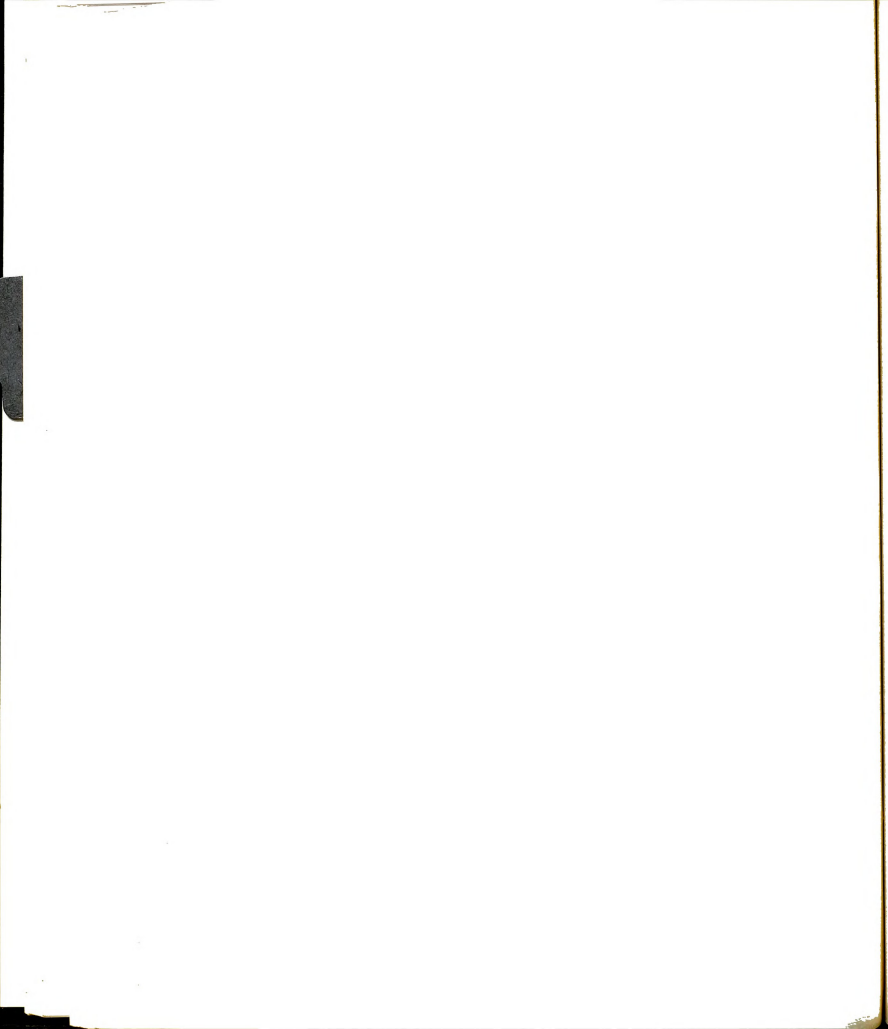
When the trainee completed all of the lessons in a series, and likewise all of the series, the instructor reviewed and tabulated a weighted overall average evaluation which gave an accurate indication of the trainee's attitude and his attainment of the desired behavioral objectives. This "one grade" is then based on a realistic appraisal, supportable by sound judgment, and a performance rating based on a rational and continuous evaluation of an individual's progress and potential.

Objective evaluation cannot be claimed for a "single grade" assigned at the end of the course by an instructor after the training is done. Too often bias and prejudice, as the result of some temporary short



coming, will cause the instructor to down-grade a trainee who otherwise has done well. Furthermore, the instructor may let his personal likes or dislikes "unduly influence" his final decision if he must suddenly come up with one grade after the course or training is completed. Some trainees and students are particularly adept at what is commonly called "brown nosing" and may take advantage of a weak-willed or non-objective instructor. Some instructors also do not like to be challenged by their pupils and will penalize the otherwise superior student by "putting him in his place" by down-grading him. They may then rationalize that the smart student was obstreperous or a threat and "deserved" what he got.

Form EV-4 was designed to serve as a permanent record of the trainee's achievements (Appendix C). It is filled out using the data collected in the daily evaluations of individual lessons. This form was given to the trainee along with the certificate showing that he successfully completed the training program. Spaces were provided for test scores from the aptitude tests, if these were taken, as well as for the actual scores received by the trainee on the Final Evaluation Events discussed in the next section.

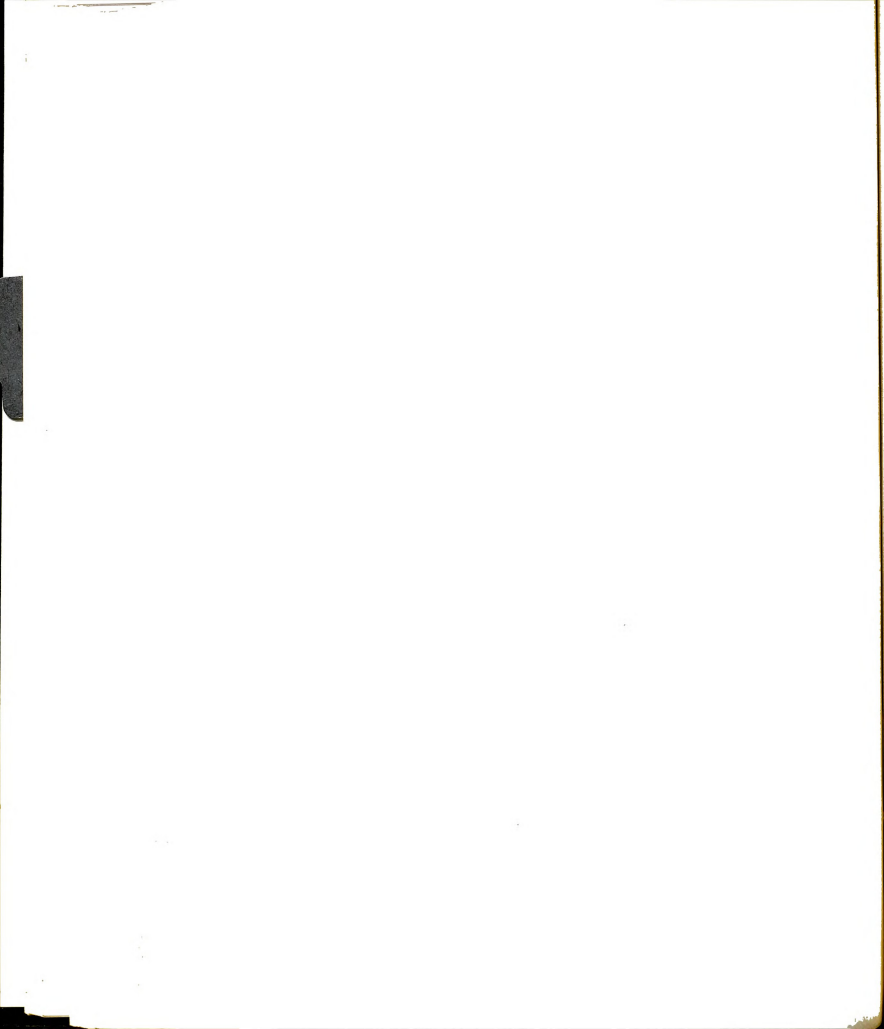


Post-Training Tests

Final Evaluation of Trainees

Criteria for Performance Testing.--To set quantifiable training objectives, suitable for performance testing, the job was looked at to see what the worker does and the conditions under which he worked. What judgments and decisions must he make and what knowledge is required? What problems are likely and what is the worker expected to do in each case? Performance criteria are the testing criteria for determining if the trainee has mastered the objectives required by the job. Training cannot be proven to have taken place if the training objectives cannot be stated and tested in quantifiable terms.

To define good job analysis in the Basic Tractor Operators' Course, the skill and knowledge factors were isolated and then quantified by applying dimensions to the questions, "How well must it be done," and "How well must it be known?" Measurements were expressed in terms of time, accuracy and/or completeness. The values used as the training objectives, and test criteria, represented the performance of an acceptable, minimally qualified worker. By building a test item for each key objective in the lessons, it was possible to describe the minimal capabilities of any man who successfully completed the program. Thus, testing approached certification.



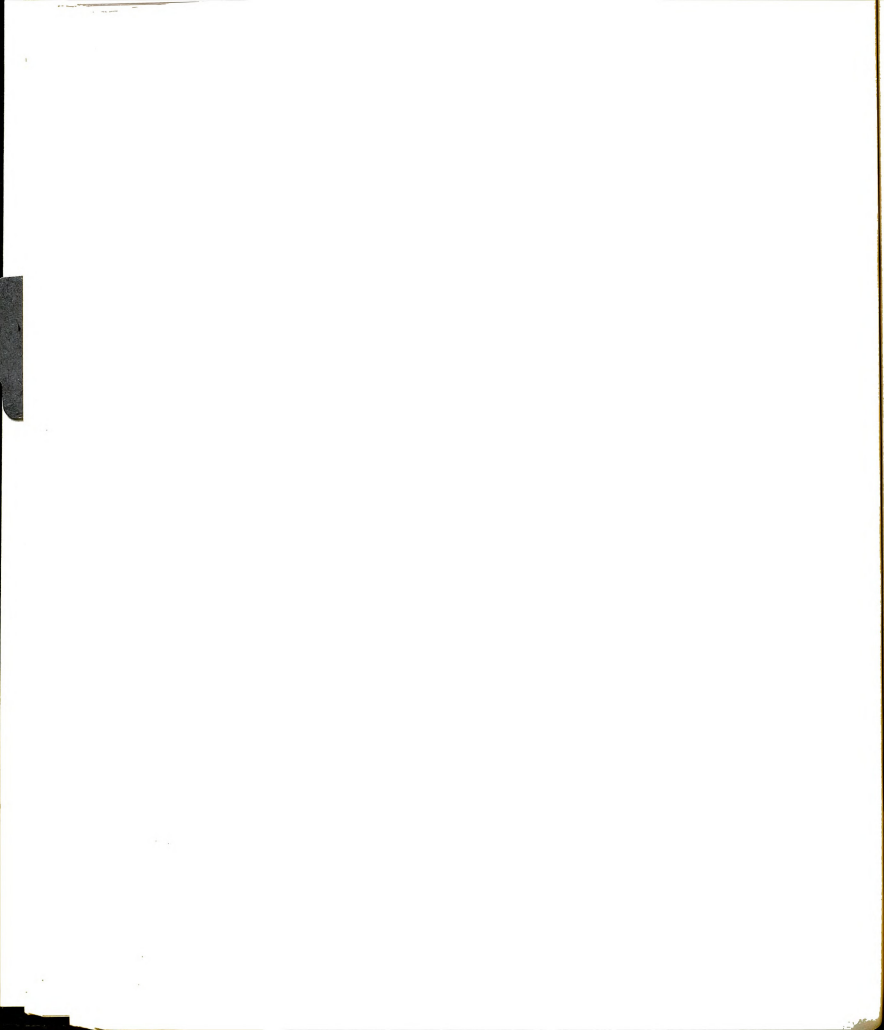
Performance testing evaluation was based on real work tests closely replicating the job environment. Performance on a paper and pencil test is no guarantee that the trainee can do the job. Considerable imagination and work was required to construct a performance-based training and testing program.

In cross-culture training, translations must be used with great care. Goss pointed out,

since any use of graphics requires symbolic translations on the part of the learner, and each translation offers possibilities for error, the trainer should minimize such translations. Photographs or real hardware are preferable to stylized drawings. Good drawings are better than words. The trainee should not be required to give written responses unless written responses are a part of the job (W. R. Goss, 1970, p. 48).

For example, when it was impracticable to use real instruments, actual photographs or drawings of the instrument with different readings were used. The trainee was required to make the readings with the required accuracy and within the given time standards for the real job. The testing stations were also like the real world job situation. As Goss (p. 48) again emphasizes "Only with real performance testing is it possible to guarantee or certify competence of a trainee."

The final testing plan was based on the stated training objectives. In a complete analysis, all need-to-know items must be distinguished from the nice-to-know. The latter were eliminated from the test and carefully



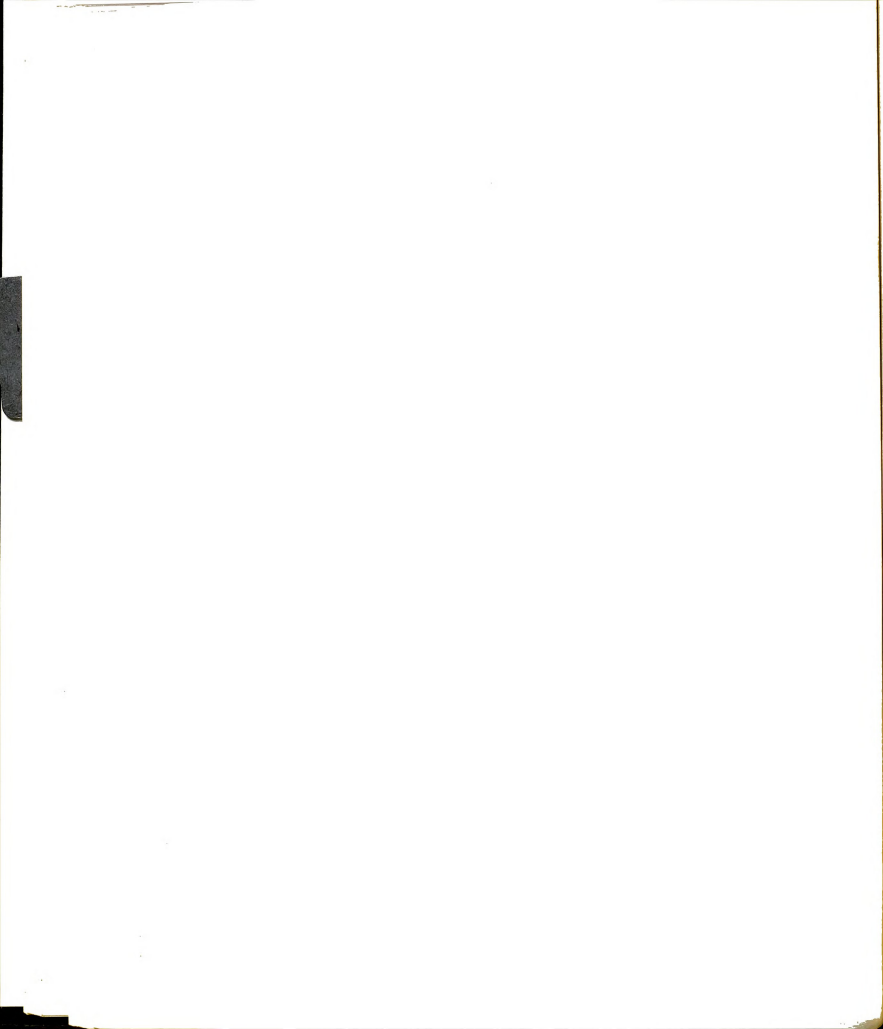
reviewed to see if they could be dropped from the training course to increase the cost-effectiveness. Goss (p. 48)

says

the test should be constructed so that a fully qualified trainee will score 100 percent. That is the only passing grade. A trainee who cannot score 100 percent is not ready to go on the job and some kind of retraining or remediation is required.

Ideally, the test would cover every item of critical skill and knowledge in simulated job conditions. By testing, the trainer can isolate those areas where knowledge, skills and even attitude is inadequate. If a trainee cannot respond at the entry level for a job, he needs additional training, but only in those areas where testing has indicated a weakness.

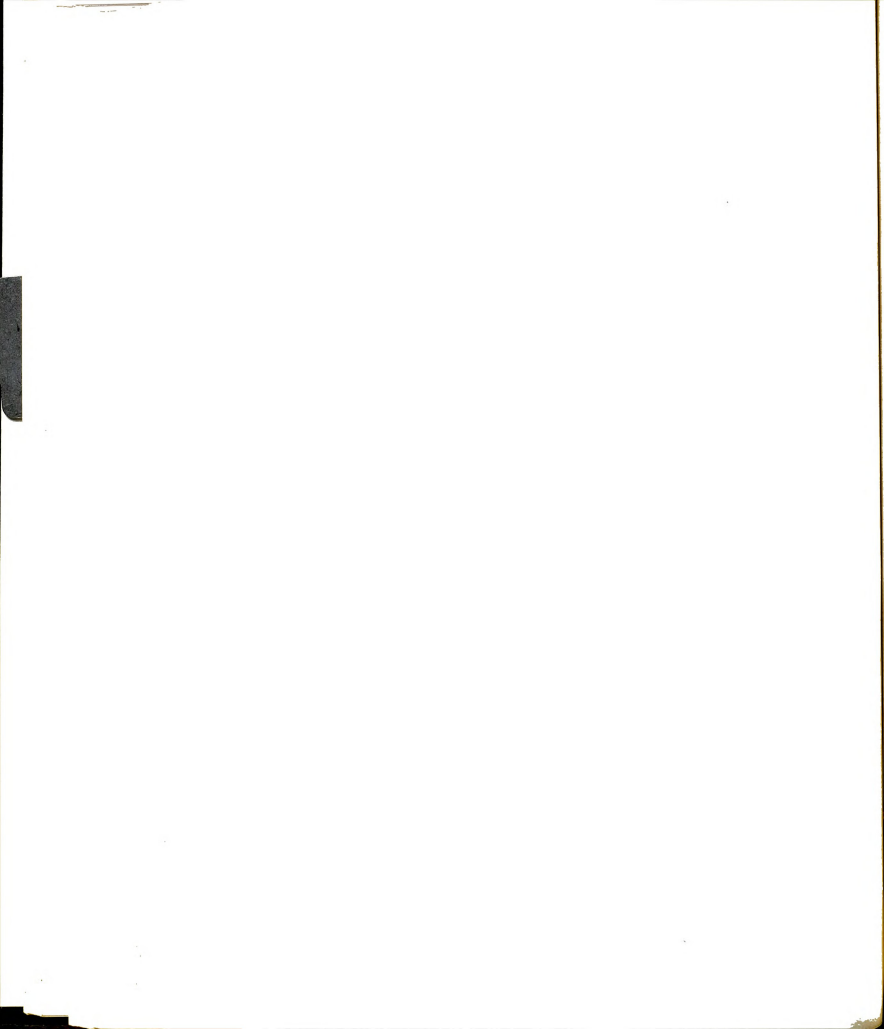
When the testing had been carefully and realistically developed, the instructional program was written to simply teach the test. Testing methods used in the real world were used in teaching. While some simulators were used, actual objects are much better and were used for all training whenever they were available. Photographs can be used but as Goss (p. 48) points out "if it is necessary to use photographs for testing, these should be the key elements of the training package." All decisions on course content, material format, program duration and media selection were made on the basis of the testing strategy and test design.



Prior to building the program around a test design, the tests were used as pretests on a sampling of intended trainees to determine their validity. The idea of using the same test at the beginning and end of the program constitutes a breach of security in "traditional teaching." However, if the test is truly a performance test, the main concern is that the trainee be able to pass the test, and not how he gets the information. In fact, if the trainee could study at home and/or get answers from his companions, it would be just as good as formal classroom training, and much less expensive.

Setting Performance Factors.--Qualification as a Basic Tractor Operator was based on attainment of a selected number of key Attitude, Skill and Knowledge (ASK) points. Items considered crucial to development of a satisfactory level of achievement were indicated with an asterisk (*). To pass the training program and be certified as a qualified Basic Tractor Operator, Grade I, each trainee had to know or be able to perform all of these steps with a positive attitude. There were all degrees and shades of "satisfactory ASK" and each trainee had to be considered individually, as well as collectively, in comparison with others.

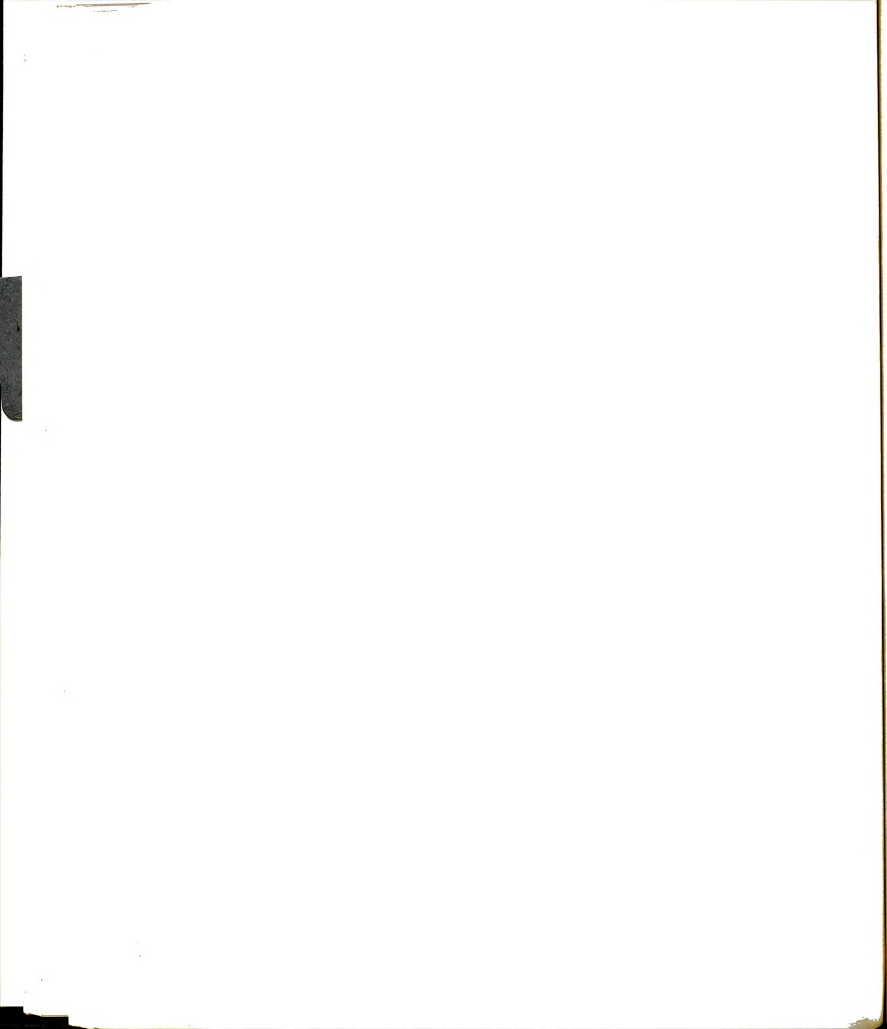
To establish some reasonable guidelines for ASK attainment a Trainee Activities exercise was developed for each lesson (see Lesson B-9 on page 169, Chapter III).



Each key point marked with an (*) was based on a behavioral objective. Since it is impossible to evaluate each trainee in a Final Evaluation on every single point covered during the course, special events were developed to selectively cover a representative cross section of the critical ASK points in the course. These points are covered in the Seven Final Events partially illustrated in Appendix D.

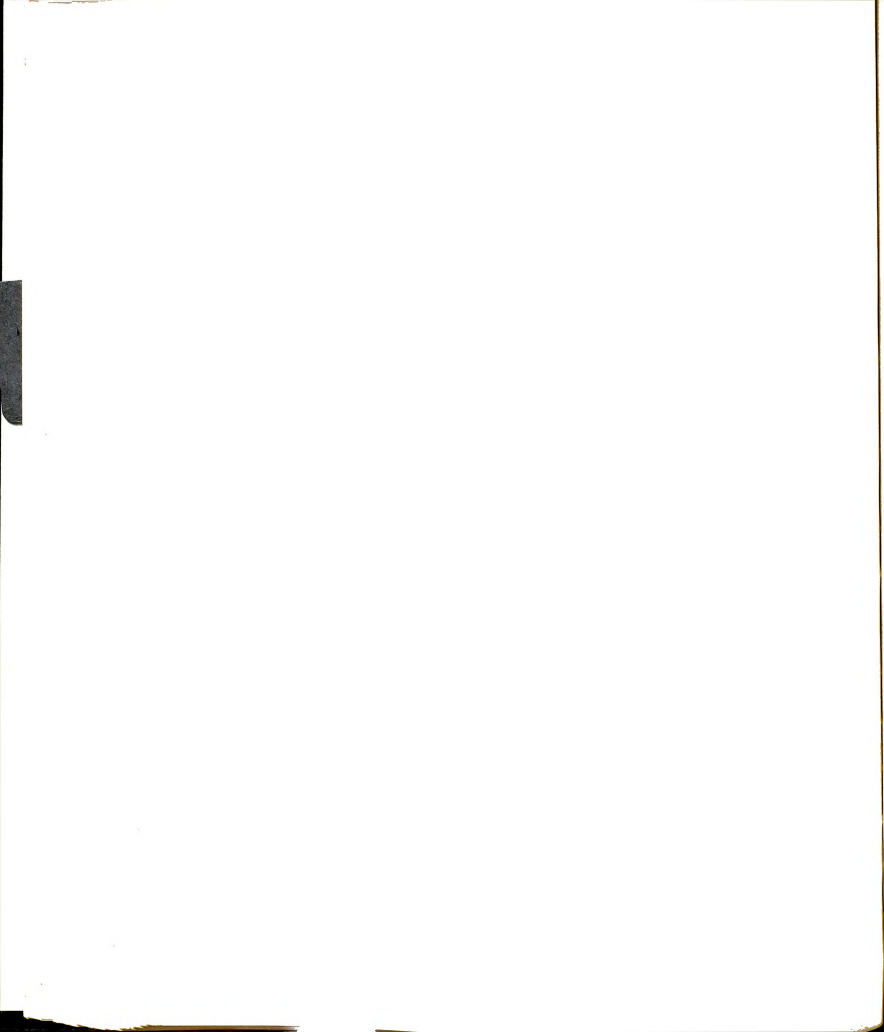
In addition to the starred items (*), there were a number of other points in each lesson which would be helpful for the trainee to know, but which were not considered crucial to the basic job performance. They were generally stepping stones in the learning process or they furnished additional information to the more capable trainee. If the trainee knew and can do most of these non-starred points, as well as the starred ones, he was a "superior trainee" who would probably make a better-than-average tractor operator. If the trainee did not know all of the starred points, he was deficient but could probably be brought up to standard with some extra work. If the trainee could not keep up with his peers and just did not seem to "catch on," he was considered sub-standard and not of sufficient caliber to warrant further training.

Using Outside Evaluators and Judges for the Final Evaluation.--In order to evaluate all trainees in a reasonable time, it was necessary to conduct three to



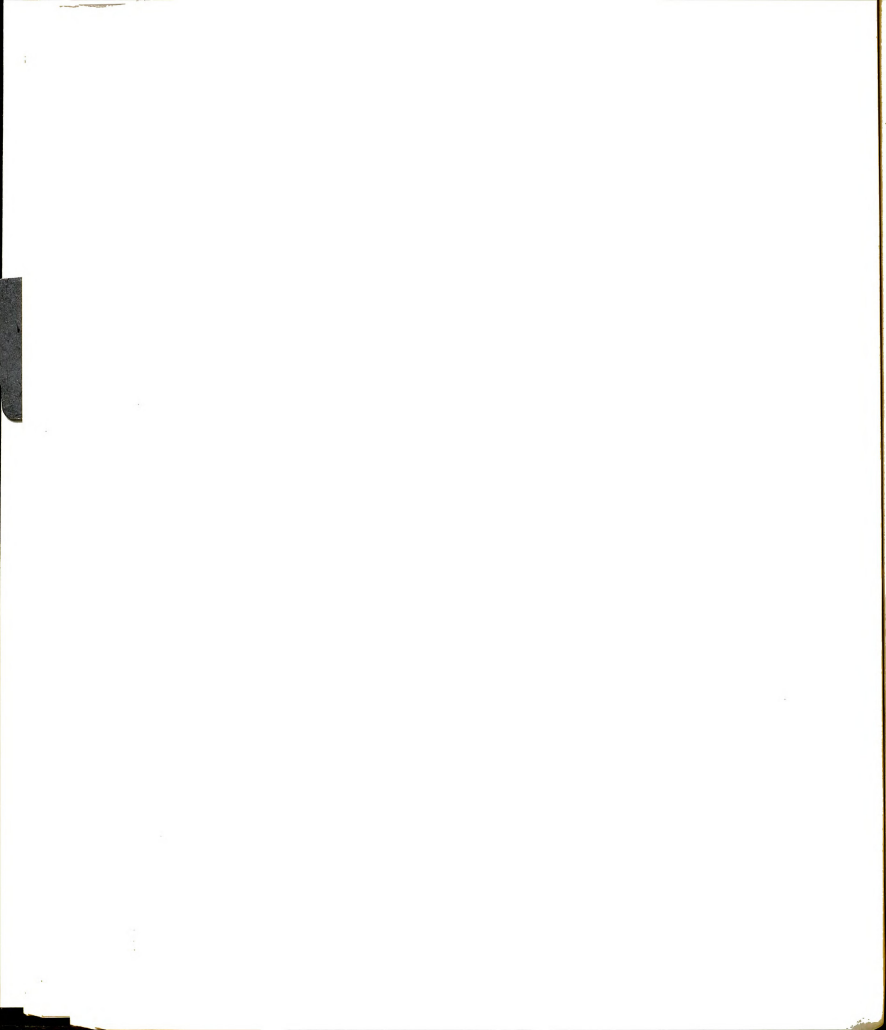
four of the Final Evaluation events simultaneously. This use of outside judges and officials in the final evaluation was very beneficial. First, the trainees knew they must perform well and they were apt to do much better and try harder since they realized this was serious business. They were, in fact, judged on what they could do! They also had to show a stranger that they knew how to do it or understood the question. Second, this provided more realism and objectivity, and also prevented the instructor who may have been teaching the trainees from jumping to unwarranted conclusions. The trainee may have known it several days or weeks ago, but does he know how to do it now? Third, outside evaluators probably treated all trainees alike and were less influenced by past events. They tended to avoid the pitfalls of prejudice because the trainee was just an individual, judged solely by his performance and ability based on a unique set of circumstances which allowed a fair comparison between him and the course objectives. The regular course instructors helped with the final evaluation and acted as time keepers, safety judges, etc.

The judges and officials were carefully trained and rehearsed so they knew what to expect; and so they also presented a uniform set of test conditions. They understood each skill and attitude and could assess a fair grade. The assessment of attitude was made much



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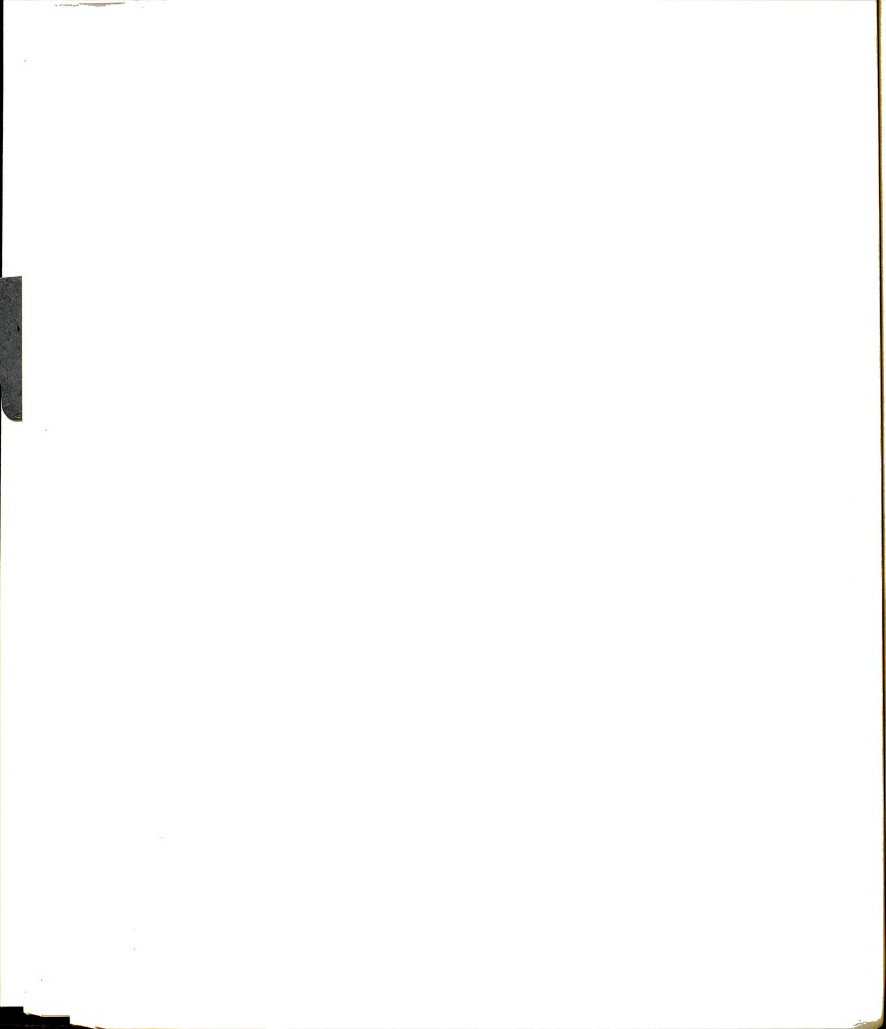


less difficult by looking at it as either "positive" or "negative." If it was impossible to clearly reach a decision, the attitude was considered "neutral."

Evaluating and Recording ASK on Trainee Permanent Record Form EV-4.--The results of each Final Event were recorded on individual score sheets. The Safety Score Sheet, Event No. 1, was used to record the safety violations for several events. After the evaluating, scoring and recording were completed on the Event Score Sheets, the final results were posted on the Trainees' Permanent Record. See Appendix C.

The trainee record form was designed as a one-page summary sheet of the trainee's performance during the total training program. Space was provided for daily and final evaluations of each lesson. Space was also provided for scores received during final evaluation when the seven events are used. The instructor took time to compute the class average for the final evaluation and ranked each trainee in his class. Copies of this record were used as reference for possible employers of the trainees receiving certification from this training program.

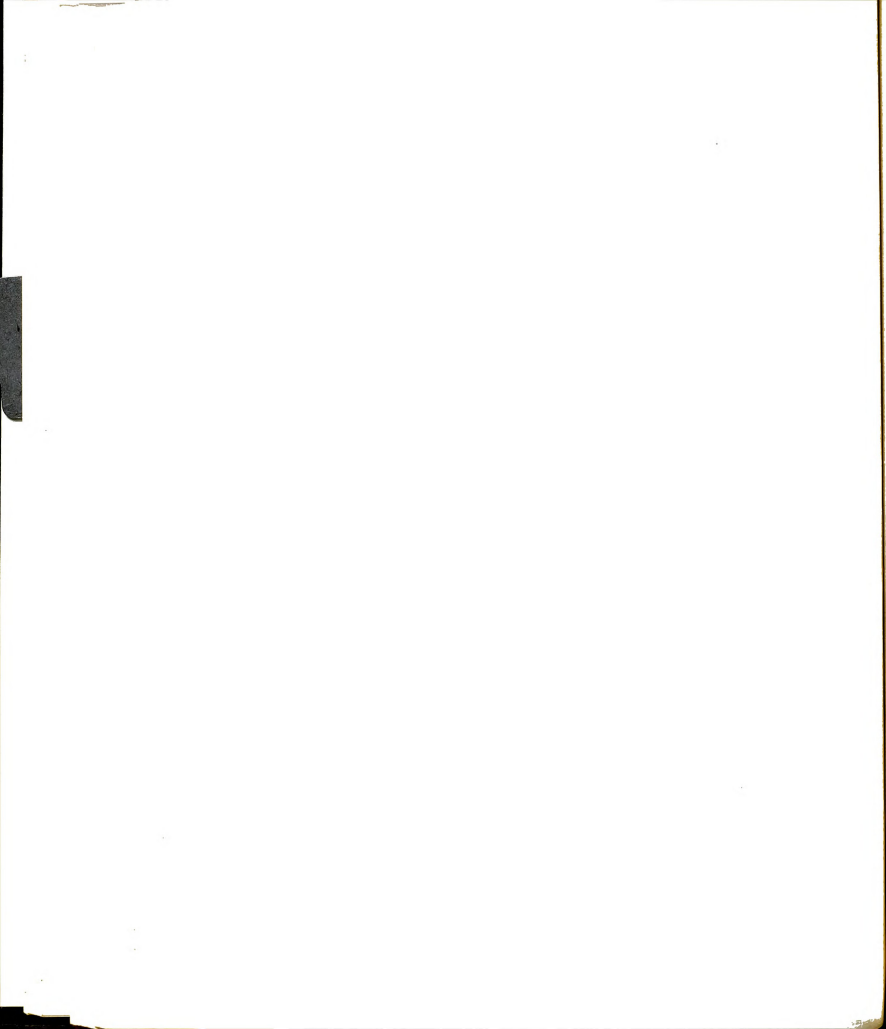
Testing the Qualifications of Basic Tractor Operator Trainees by Complete Retesting.--Although each trainee was evaluated daily to ascertain his progress, it was considered essential to carry out a final evaluation to measure his retention of skills and knowledge after training.



The final evaluation was done primarily on a 1:1 instructor-to-trainee ratio. This was based on the need for accurate evaluation of the trainee's ability to perform the required skills unassisted by any other person. To qualify as a Basic Tractor Operator, a trainee had to perform all or 100% of the starred (*) items on the activity sheet and flow chart checklists. The oral or written post-tests were given as a group exercise with each trainee marking an individual score sheet. Trainees were placed so they could not copy from each other.

Some reasons for testing were to (a) motivate the trainee, (b) help the instructors and trainees check their progress, (c) find gaps in learning, (d) provide a measure progress, (e) set and maintain standards, (f) use as an effective teaching tool and (g) use as a guide for counseling. While the aptitude test indicates whether a trainee "can learn," and the achievement test "has he learned," the proficiency test measures "how well he can apply what he has learned."

The final evaluation can be performed by two different methods at the discretion of the instructor. The first method re-evaluates the competency of the trainee in the skills and knowledge of each lesson by testing for all the starred items in each activity list and by giving each of the pretests again as a post-test. This would, of course, be a very long and detailed means



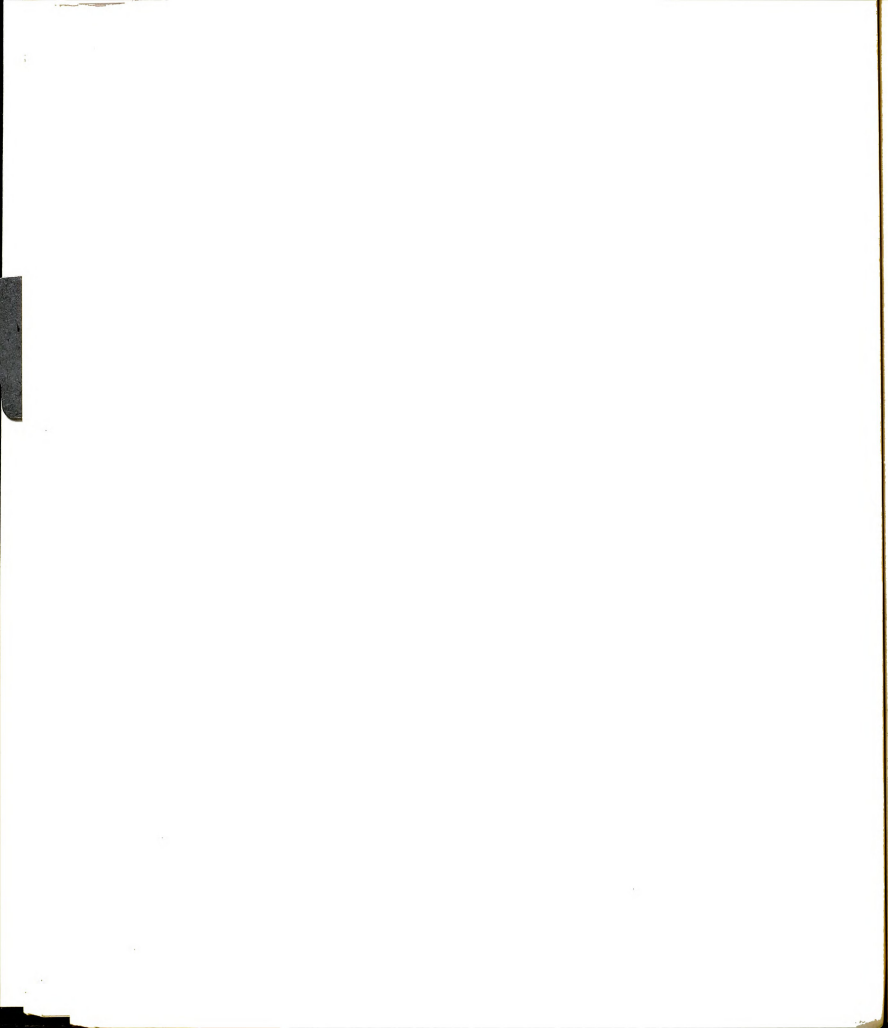
of evaluating each trainee. But, when it was completed the instructor would have a complete picture for judging the competency of the trainee. The flow charts with the critical items starred (*) can be used to check the judgment and skill aspects of the training program. The information would be recorded on a second daily evaluation sheet and the results transferred to the appropriate part of the Trainee Permanent Record Form EV-4, Appendix C.

Testing the Qualifications of Basic Tractor

Operators by Selective Testing.--The second method of evaluation tests for only selected or crucial skills and knowledge determined to be representative of the total course of instruction. This method was adopted for the final evaluation of Basic Tractor Operator trainees. Seven different events were developed for comprehensive performance testing of each individual trainee on safety, driving, machinery operation, maintenance, attitudes and knowledge based on the pre-post tests as follows:

- Event 1. Driving Safety
- Event 2. Two-wheeled Skilled Driving Course
- Event 3. Attaching and Detaching Drawbar and PTO equipment
- Event 4. Using the 3-point Hitch Mounted Mold-board Plow
- Event 5. Daily Maintenance Services
- Event 6. Weekly Maintenance Services
- Event 7. Oral or Written Post-Tests.

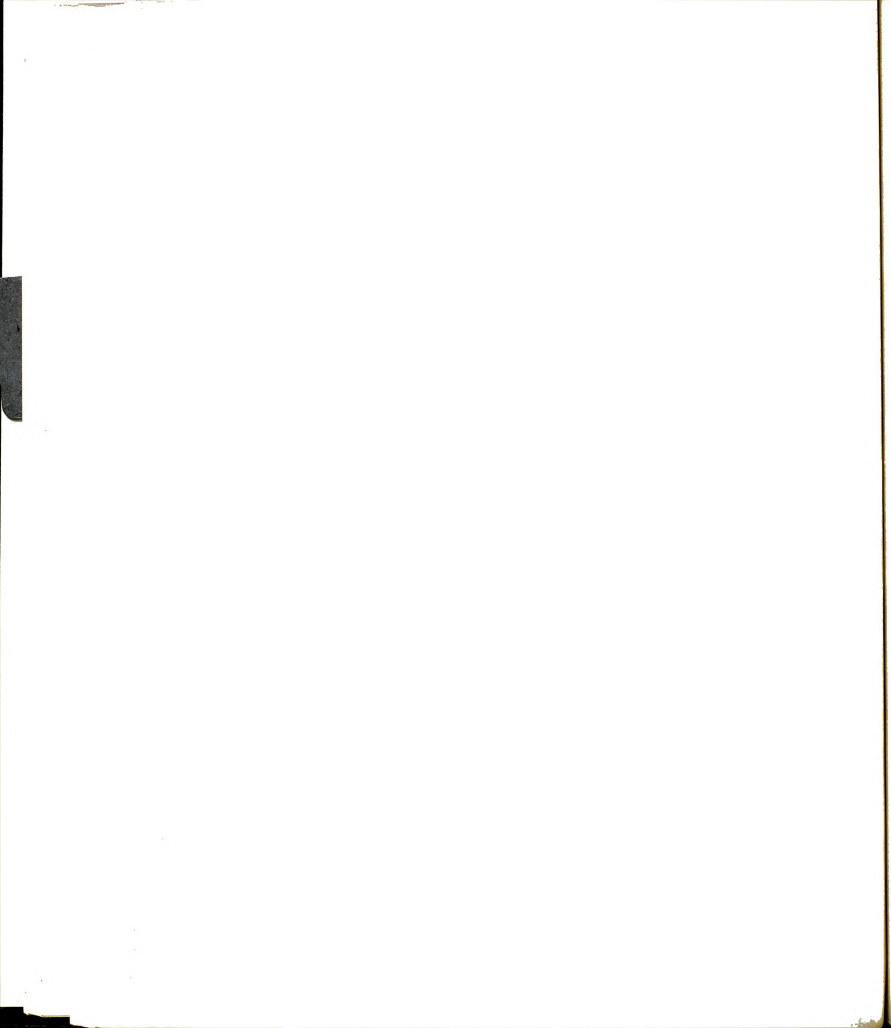
Event 1--Driving Safety: Since one of the main objectives of this training program was to instill correct attitudes and safety habits, each trainee was



graded for safety at the same time he was evaluated in events 2, 3, and 4. In these events one judge or evaluator was given the sole responsibility of watching for unsafe practices. Each time an unsafe practice was observed it was recorded on the contestant's form for Event No. 1. The same form was used for all events (2-4). There was no time limit in this event. See Appendix D.

Event 2--Two-Wheeled Trailer Driving Course: In this event the operator backed a tractor to a two-wheeled trailer or implement, hitched the implement to the tractor (adjusted the drawbar if necessary), then backed and drove the tractor and trailer through a predescribed and marked course, being careful not to deviate from the prescribed course. This event took an average of 20 minutes per trainee. While points were deducted for excessive time, this was not a speed test. Trainees not taking other tests were allowed to watch this event. An audience increased the competitive spirit and generally the quality of performance.

Event 3--Attaching and Detaching Drawbar and PTO Equipment: In this timed event the trainee backed the tractor to a piece of PTO-driven equipment, adjusted the drawbar if necessary, attached the implement and PTO connections, started the equipment and brought it up to the recommended PTO speeds, stopped the PTO, then unhitched the implement and put the tractor back in its original



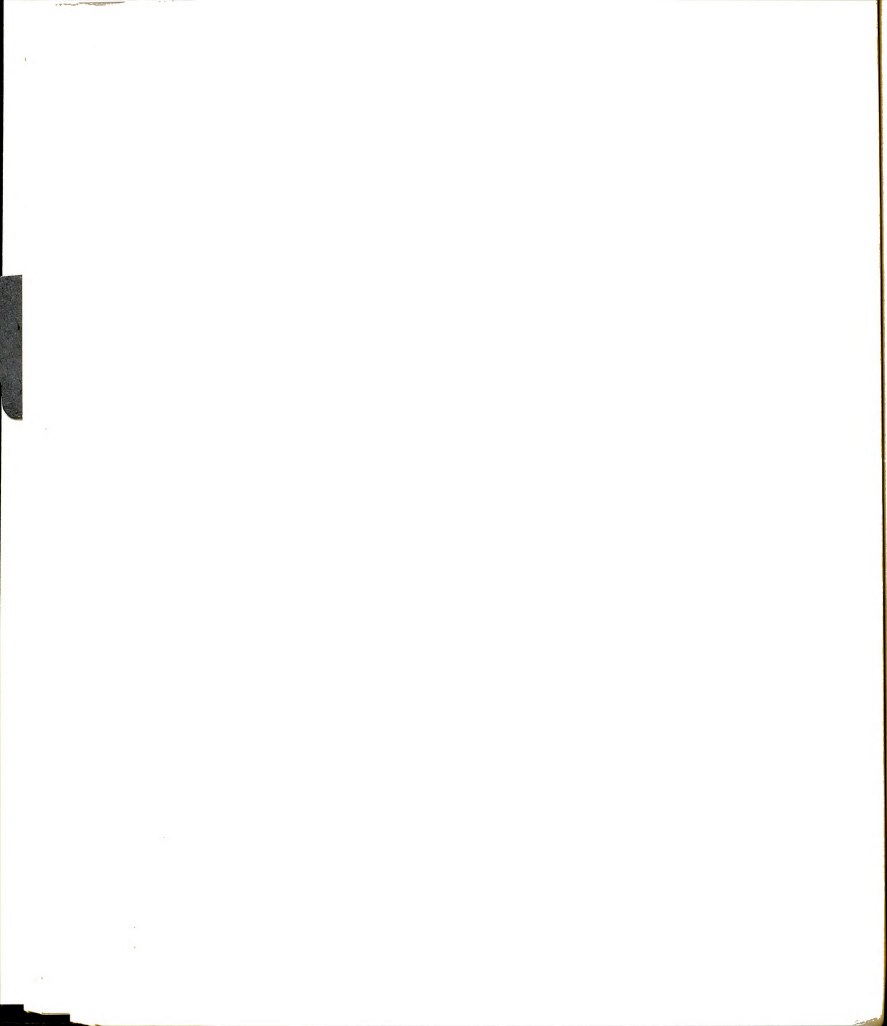
position. This event took 15 to 20 minutes per trainee with points deducted for excessive time.

Event 4--Hitching, Adjusting and Using the Moldboard Plow under Field Conditions: In this timed event, the trainee backed the tractor to the plow and attached it, adjusted the hitch if necessary, took the plow to the field and plowed one round, made the necessary field adjustments, returned the plow and tractor to the original position, unhitched the plow and parked the tractor at the starting point. He was scored on safety, quality of plowing and efficiency of work. This event took 20 to 30 minutes per trainee. See Appendix D.

Event 5.--Performing Daily Maintenance Services: In this event, the trainee performed all of the daily maintenance services on the tractor provided. He was scored on his thoroughness and ability to carry out the required maintenance. This event lasted 20 to 30 minutes per trainee. Trainees not being evaluated were not allowed to be present while another was being tested in both this and the following event because of staged maintenance deficiencies.

Event 6--Performing Weekly Maintenance Services:

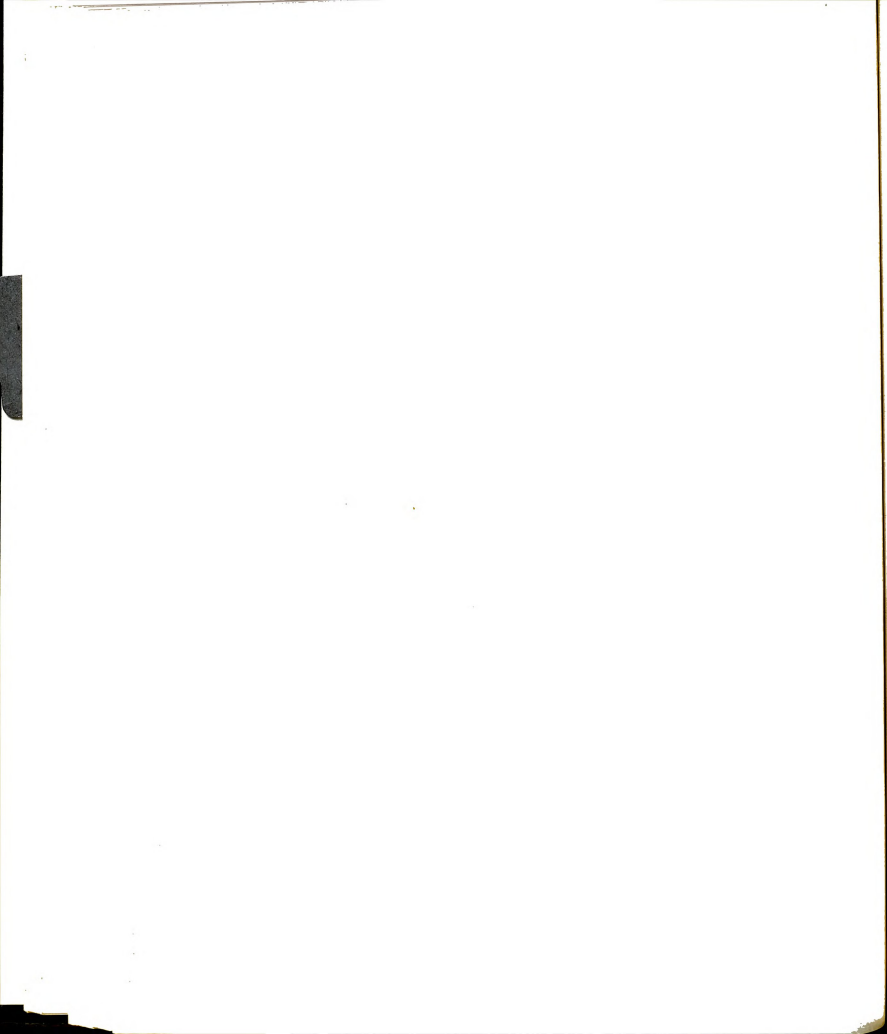
This event was similar to Event 5 except that the trainee was asked to perform all of the weekly maintenance services required on the given tractor. The scoring and the time required were the same as for Event 5. See Appendix D.



Event 7--Oral or Written Post-Tests: Each of the previous events may be carried out concurrently if there are enough judges to score the various tests. The oral and/or written post-tests were carried out as Event 7 with the total group of trainees. If the trainees cannot read, the instructor read the questions to them. Each trainee used a master answer sheet provided to record his answers. The 150 selected questions were taken from the previous pretests included in the manual. For scoring purposes the total points recorded on the final evaluation form were the number of items missed. The total number of correct answers was not recorded.

The points for each event were added together for the total raw score. In all of the events the points given were negative, i.e., they were for things that the trainee failed to do, or did improperly. The individual events were ranked with the lowest score receiving first place and the highest score last place. The final evaluation took 1½ to 2 days for the total group. Details on the procedure to follow in carrying out each event were given at the beginning of each event's evaluation form or scoring sheet.

Certification and Follow-up.--Upon successful completion of the training program, the trainee was certified as a qualified Basic Tractor Operator, Grade I, and given proper recognition. Two formats were suggested for



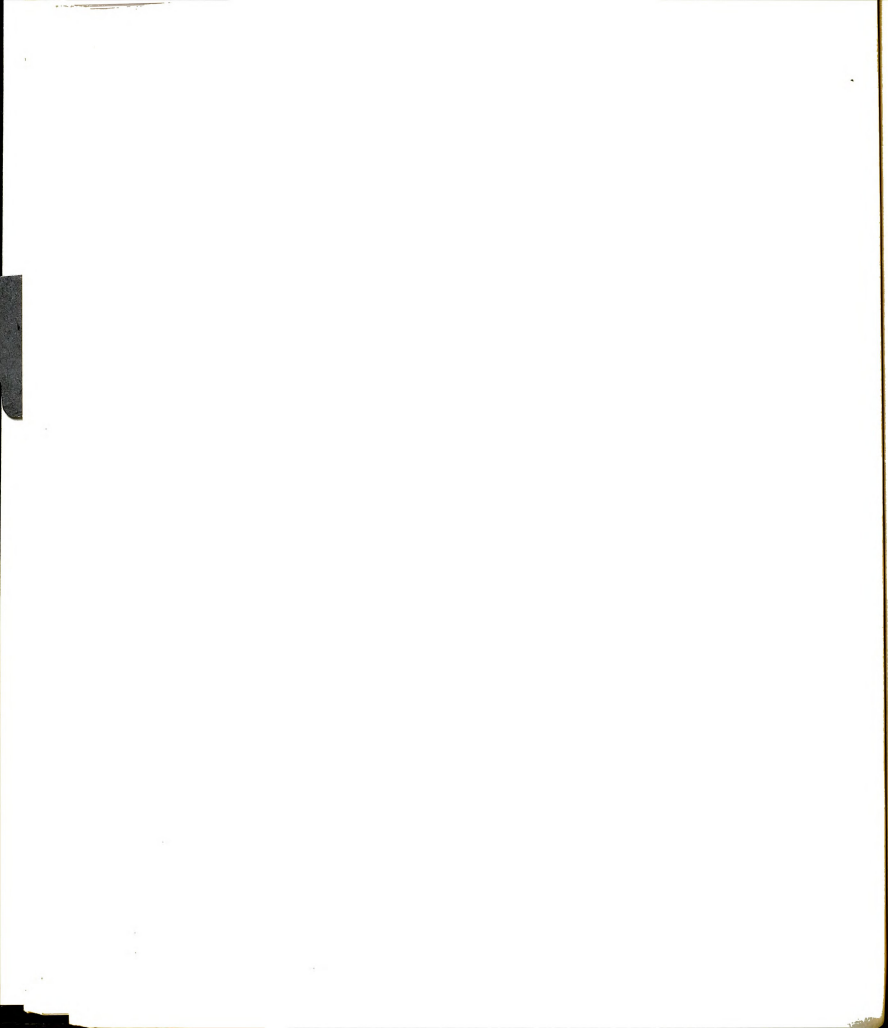
a possible certificate. See Appendix C for a sample of one format. At the graduation exercise the certificate was presented with proper honor and ceremony.

Care was taken to keep the certification standards high. This reflected a good image for the training program as well as the trainees. For this reason, minimum standards (the starred (*) items) were delineated in the training course. Intensifying the training program would be better than lowering standards if trainees have difficulty meeting the basic requirements.

Proper recognition was used to increase interest and enthusiasm for training. Any method appropriate for creating this rapport can be used. Increased social status, a better position, higher wages and other incentives were used as possible motivators.

A record of each trainee's achievements while in training accompanied him as he left the program. All possible assistance was given to make sure that each successful trainee was employed upon graduation. To insure successful experience for the operator following training it was recommended that the institution sponsoring the training conduct a follow-up program. Such a program was to include

- a. systematic visits to each operator on-the-job to help him with any problems he might have;

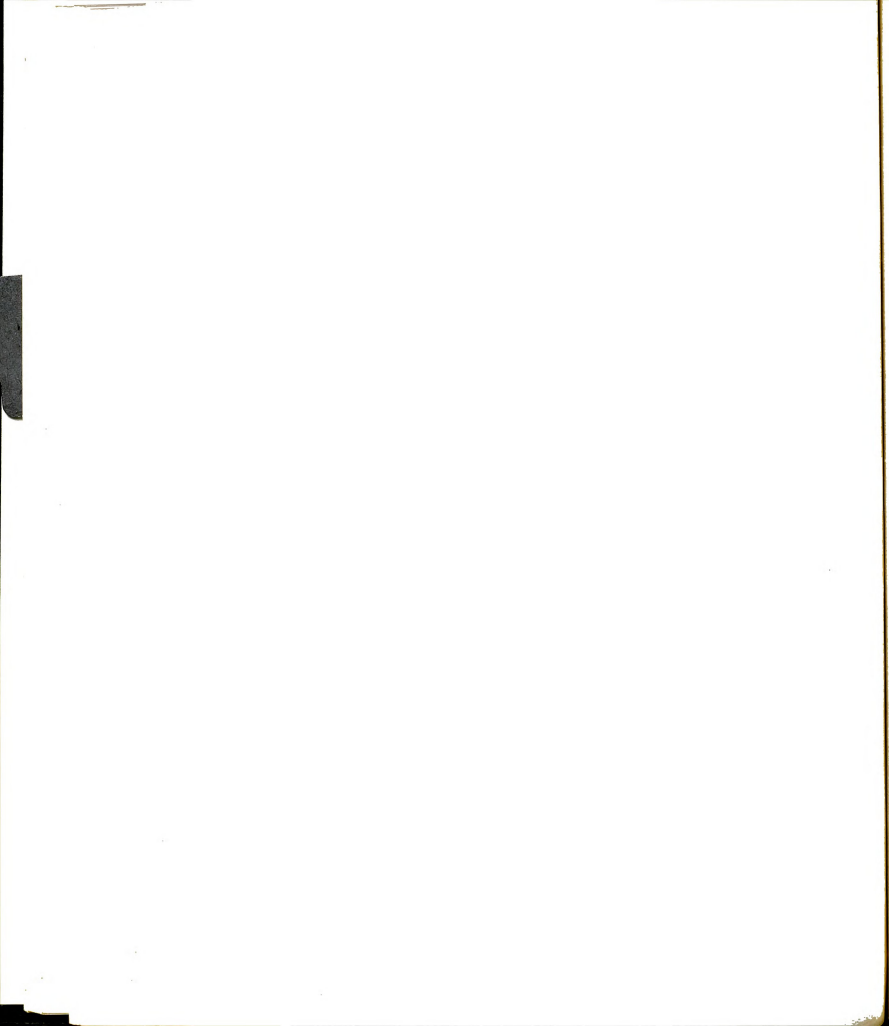


- b. recognition by rewards and incentives to encourage proper maintenance, wise use of equipment and the keeping of proper records, and
- c. follow-up refresher courses to increase competency and promote upward job mobility.

Summary

The objective of the Basic Tractor Operators' training program was to train trainees efficiently and to provide instructors with the necessary instruments and techniques for effective teaching. Highly skilled training can be given to low-education level trainees by following a carefully structured program of instruction and evaluation.

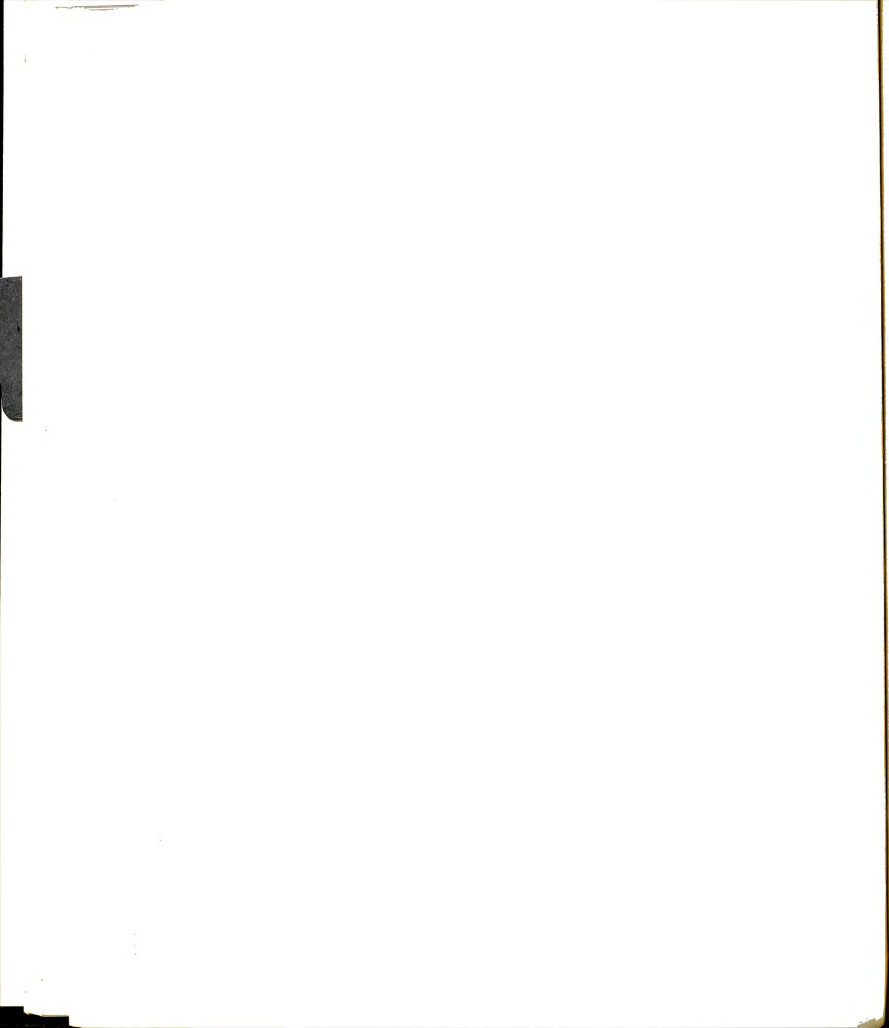
The large number of skills to be learned in a tractor operators' course makes it difficult to teach and evaluate each individual trainee without special techniques for evaluation and testing. Each of the evaluation instruments developed for the BTOC--the pretest, post-test, daily training evaluations, instructors, lesson evaluation, and final evaluation events--were discussed in this chapter. In addition the use of occupational tests, mechanical aptitude tests and general aptitude test batteries were described with their implications for improving the selection of trainees and making the training program more relevant to their needs.



To attain high training efficiency, the "lock-step" method of group training must be minimized. By using daily trainee evaluations and pretests it is possible to structure the training course so that each trainee learns only those things he needs to know for qualification. In teaching performance testing based on behavioral objectives, a practical training program should be based on four principles:

1. Accomplishment must be measured against very specific statements of measurable behavioral objectives.
2. Evaluations and tests must be planned to measure the key objectives established as standards for qualification.
3. The course of instruction must be built around the test with lesson objectives designed to prepare the trainee to pass the performance tests.
4. The training must be individualized and meet the needs of individual trainees, starting where they are and going as far and as fast as they are capable.

The instruments presented in this chapter permit the instructor to continuously check trainee progress and to measure his own teaching effectiveness.



CHAPTER V

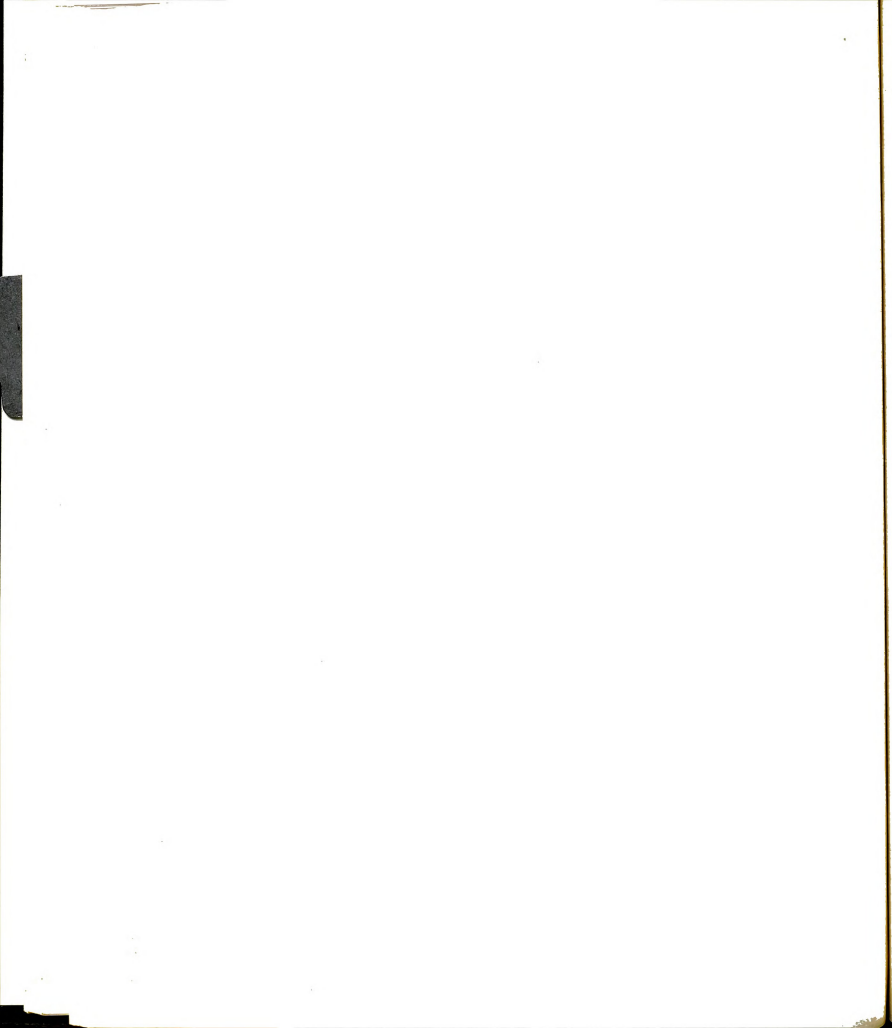
FIELD TESTING A SPECIAL PROGRAM IN MICHIGAN FOR TRAINING ADULT MIGRANT WORKERS AS BASIC TRACTOR OPERATORS

Cross-Cultural Training of Spanish Speaking Workers

United Migrants for Opportunity, Inc.

In the Grand Rapids area, the United Migrants for Opportunity, Inc. (UMOI) has worked with migrant laborers from the southern United States in an attempt to rehabilitate them into permanent agricultural jobs. In the fall of 1969 UOMI conducted an adult education class for 23 Spanish-speaking farm laborers to teach them basic English, reading and writing. After five months of part-time training ending in March 1970, the most advanced students were reported to be at about the fourth or fifth grade reading level. Some of them could neither speak nor understand the language clearly.

To qualify for better jobs, they needed practical vocational and technical training to equip them for year-round employment on western Michigan fruit, vegetable or general farms. The most critically needed occupational

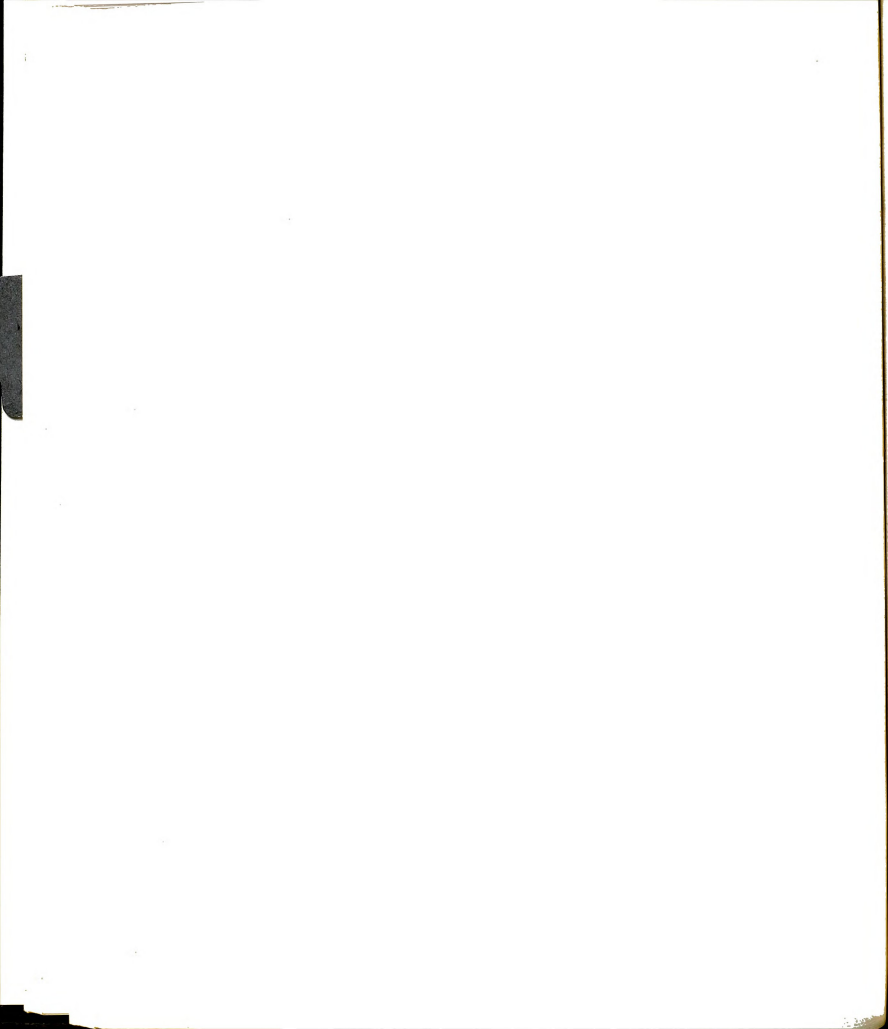


skills were reported by a Rural Manpower Survey to be tractor and machinery operators (J. S. Bolen and H. J. Doss, 1970). Growers and farmers stated they needed dependable workers qualified as tractor operators with some maintenance experience.

Through the State Department of Vocational Education and the Grand Rapids Junior College, the UOMI requested that the migrants be given training by a proposed Michigan State University Course for "Basic Tractor Operators." Although the course was just being developed by MSU it was an excellent opportunity to pretest the course early in its development.

The Grand Rapids School District hired a special master teacher and sent him to MSU for several days to be trained to instruct the basic tractor operator's course. It was also arranged for two assistant instructors to come for a one day consultation on the course. One member of the MSU staff worked with the master teacher and was present each day during the actual training to evaluate the course and practical work.

The United Migrants for Opportunity, Inc. provided each trainee with approximately \$50.00 + \$5.00 for each dependent (up to a maximum of four) per week while they took adult training. The Michigan Department of Education furnished the equipment and paid for the facilities to conduct the tractor operators training course.

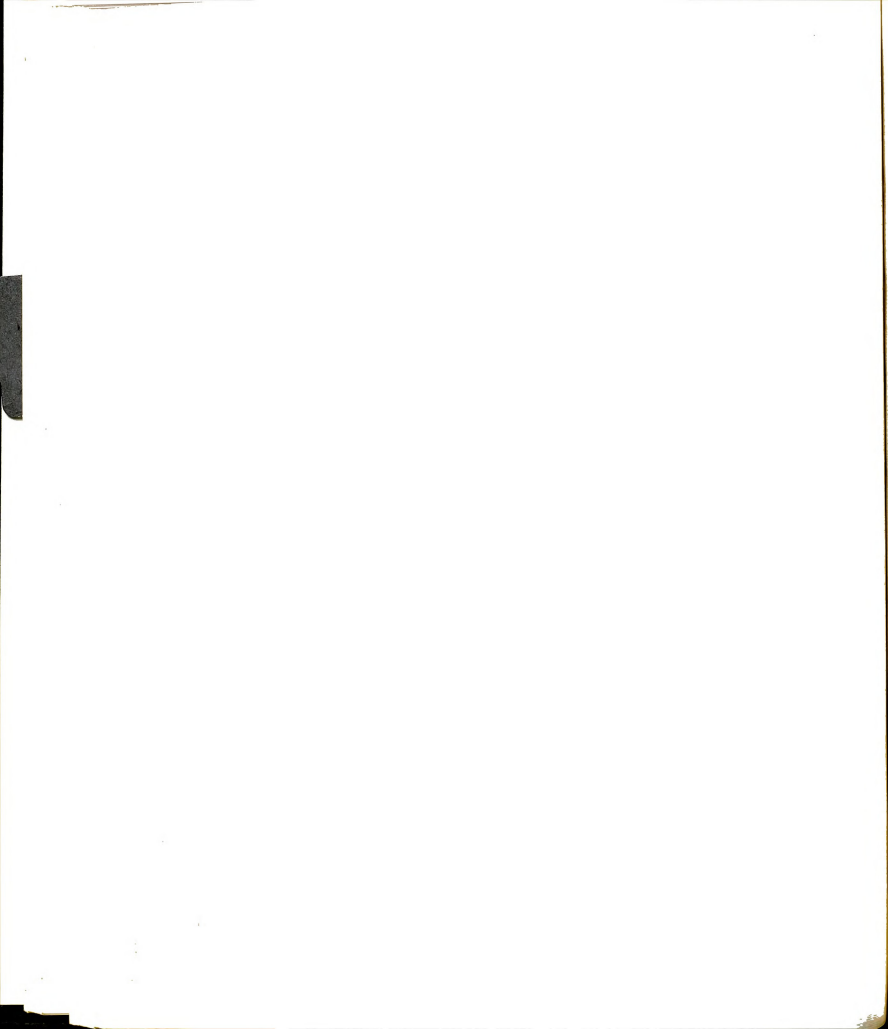


This pretest enabled the course designers to try out the training program with non-English speaking nationals to see how well it met their needs and problems. The projected time schedule was checked, the content critically evaluated, the teaching techniques refined and many of the visual aids developed and tested. The feedback was then evaluated and applied to the training program and basic tractor operator's course to improve its design and implementation.

Rural Manpower Training

The adult migrant training program was a new concept in structured education in agriculture by the Michigan Department of Education and the Rural Manpower Center at Michigan State University. It was conceived as a basic course in agricultural machinery for Michigan fruit farms and built around the Basic Tractor Operator's Course, Grade I. The purpose of the program was to provide a fundamental training course in modern agriculture for a group of ex-migrant workers. It was planned to enable persons with a low educational level to become experienced, basic Agricultural Tractor Operators and to learn basic knowledge about fruit farming operations.

The Rural Manpower Center stated that farmers, and their employees, require special training to operate modern farm machinery effectively and safely, to adjust it properly and to keep it serviceable. Most agricultural

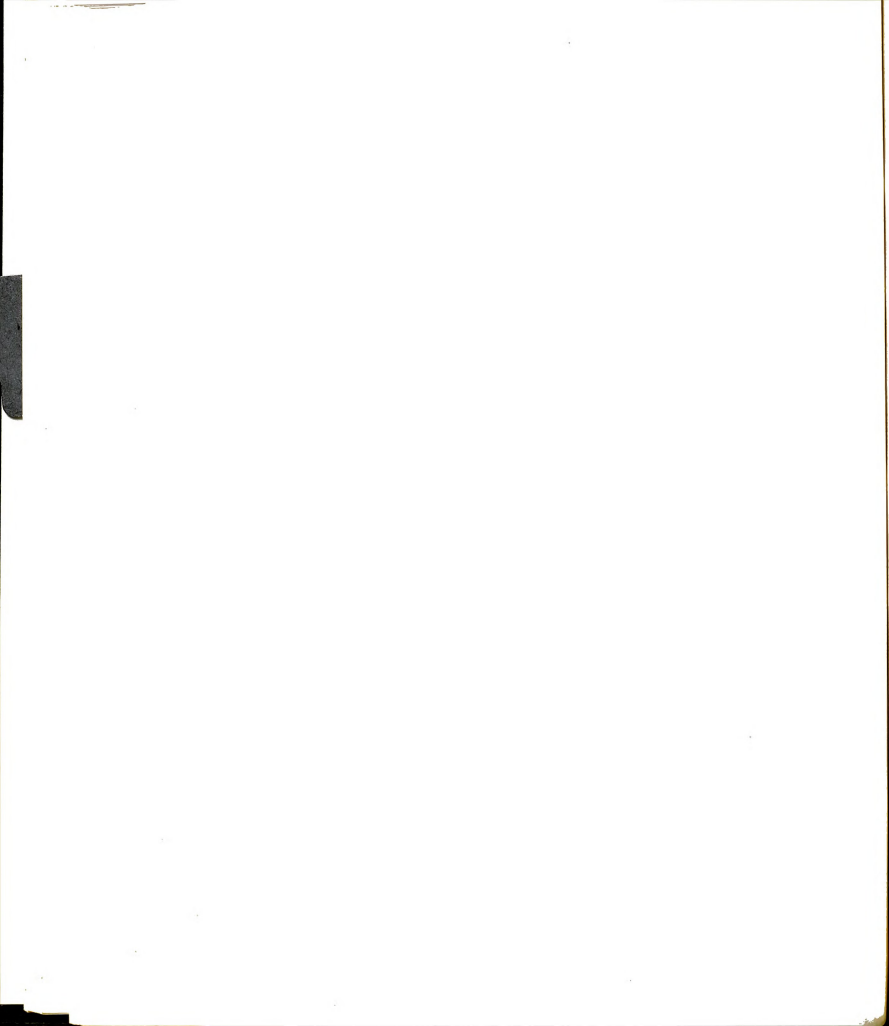


workers must be taught the basic mechanics of machine systems, the need for lubrication, service and intelligent operation.

The major objective of this course was to upgrade the operator's skill and knowledge and to create in him a new set of attitudes to permit maximum utilization of this new capability. The greatest problem of intelligently utilizing and applying farm machinery is educating the operator adequately.

Conceptual Structure of an Operator's Course

The bulk of the eight week (half-time) course was focused on the fundamentals of basic tractor care and use. A basic tractor operator was defined as one who, after training and sufficient practical experience, can operate the tractor skillfully, can use it in conjunction with selected tools and implements in specific farming operations and can properly perform specified daily maintenance and preventive maintenance services. Furthermore, he shall constantly seek to improve his knowledge and skill; have the conviction that a better understanding of how a tractor and implement works is necessary for its proper operation and maintenance; have a positive attitude toward his work; be conscientious in performing all tasks; and be dependable in carrying out instructions. If the tractor breaks down or is damaged through lack of care or abuse, he, as the operator, is to blame.



The outline for the Basic Tractor Operator's Training Course was planned in two subject areas. The first area covered a basic tractor operator's training course. The second area involved a special orientation to Michigan fruit farming operations.

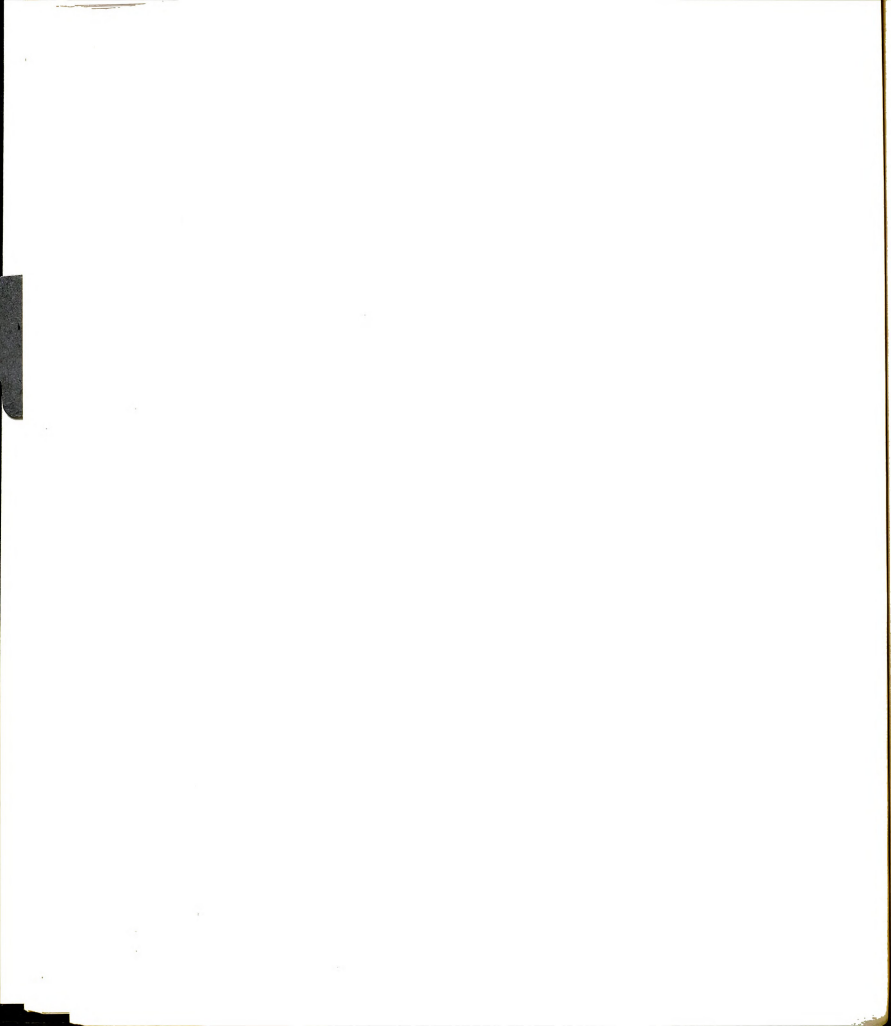
- I. A Basic Tractor Operator's Course (Diesel-Engine Wheel Tractor)*
 - A. Getting Acquainted with the Tractor
 - B. Getting the Tractor Ready for Work:
 - Prestarting Checks
 - C. Starting and Warming the Engine
 - D. Operating the Controls and Maneuvering the Tractor
 - E. Managing the Tractor: Using Good Judgment
 - F. Using the Tractor as a Power Source
 - G. Emphasis on Safety Considerations
 - H. Using the Tractor with Implements in Productive Farming Operations
- II. Special Orientation to Michigan Fruit Farming Operations (Short Course Workshop)
 - A. Operation and Care of Sprayers
 - B. Harvesting and Pruning Equipment
 - C. Spray Chemical Usage and Safety
 - D. Cultural Practices for Weed Control
 - E. Fertilizer Use and Application
 - F. Fuel and Chemical Precautions

Training the Instructors

The Need for Special Training to Develop Qualified Instructors

In any systems approach to training there is a logical sequence that should be followed in developing

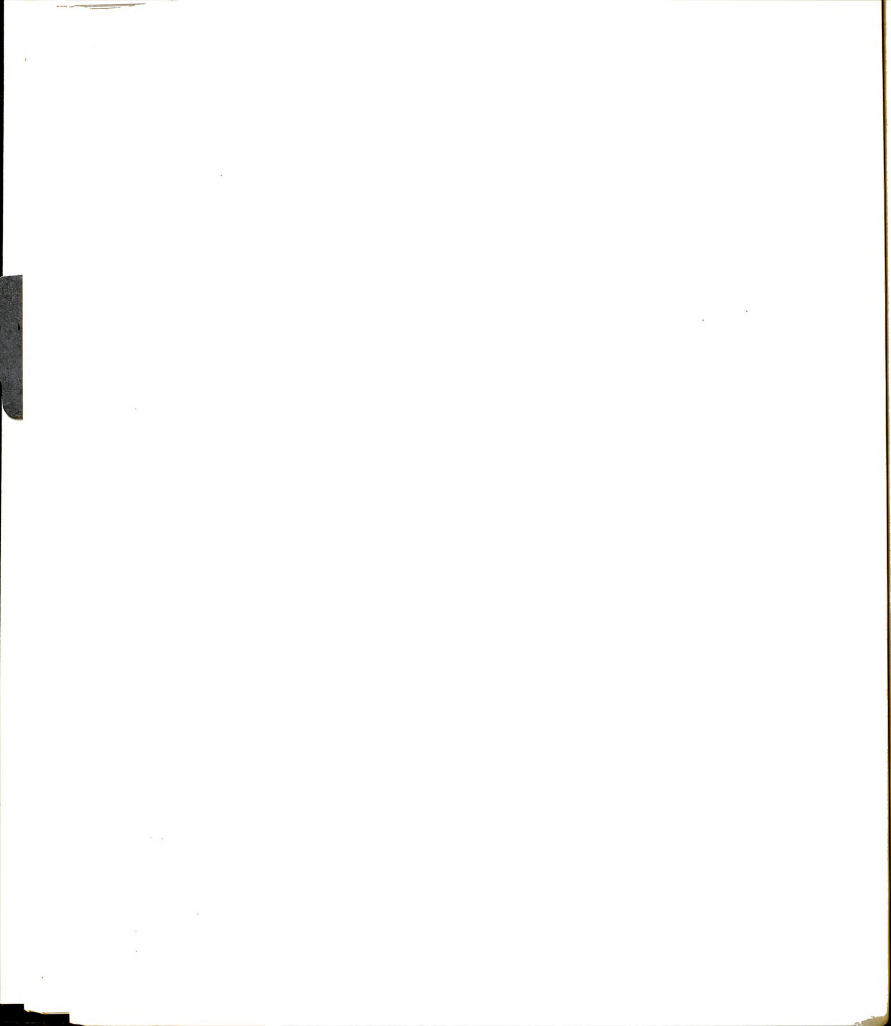
* See Appendix A for the detailed Sequential Lesson Outline under each section above.



training programs for tractor operators. Unless this sequence is methodically carried out, serious questions are raised about the social and economic value of such training and there is a high probability of failure to meet objectives.

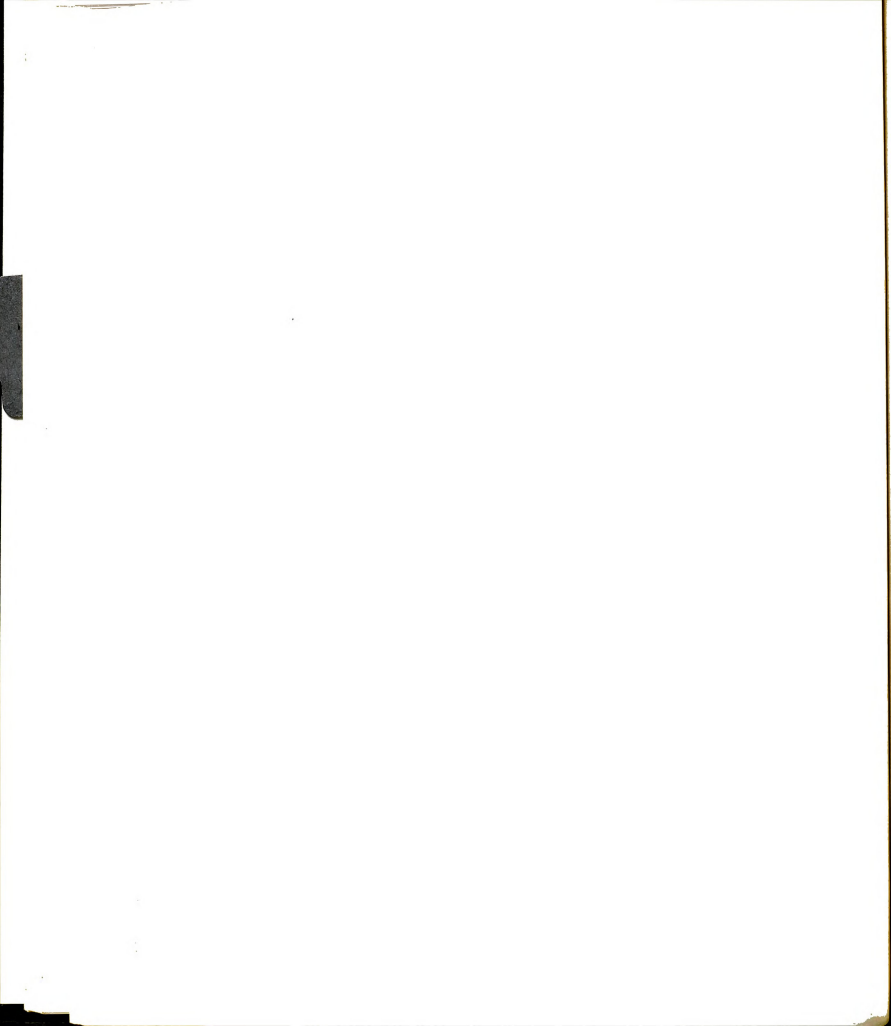
The "Instructors Manual" for the Basic Tractor Operator's Course briefly outlined the essential steps in planning and conducting a training program. It presented a structured course of methods and materials which, when carefully followed, guaranteed effective training of skilled workmen in developing nations. While none of the key steps should be deleted, the material content can be changed to fit the individual needs and entry knowledge of the trainees.

The program of instruction was written as a guide for qualified instructors. To become qualified, an instructor must be specifically trained to work with low-education level and disadvantaged trainees. For best results he should be experienced in teaching methods and knowledgeable about modern diesel tractors and farm machinery. Nevertheless, instructors should not be allowed to instruct until they have successfully completed an Instructors Training Program similar to the one outlined in this section.

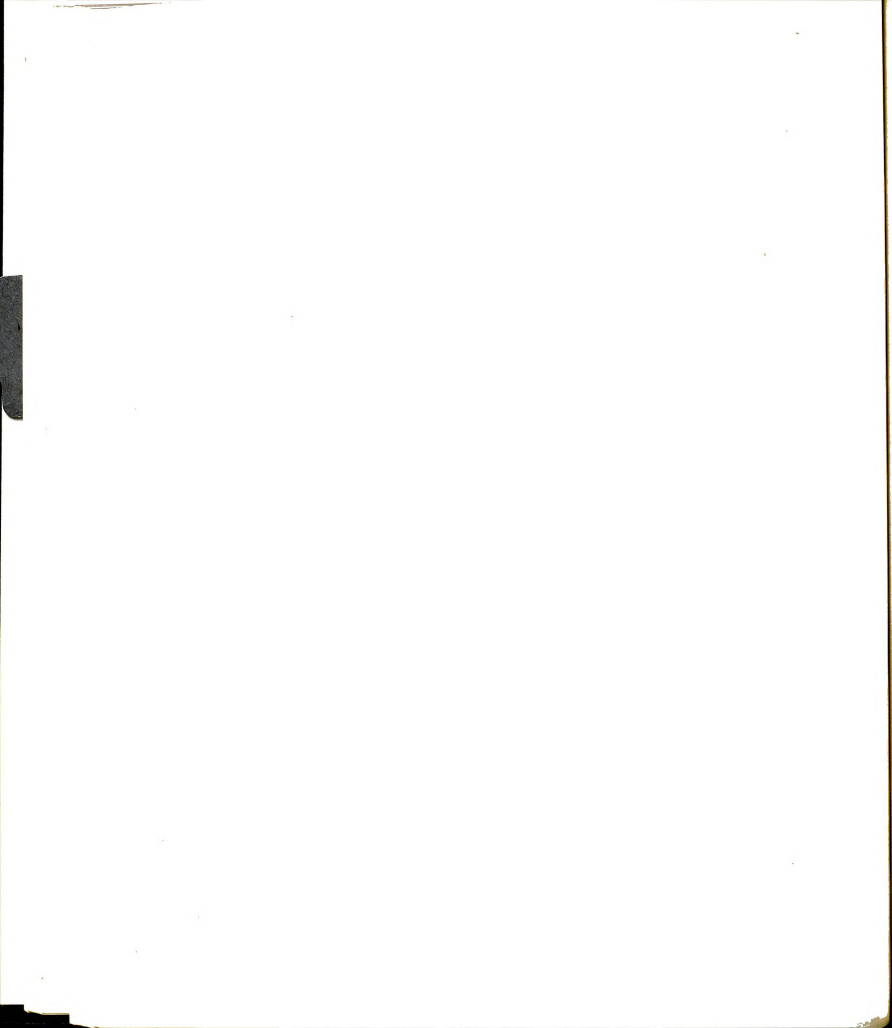


The following key steps were considered crucial for organizing and conducting a tractor operators training program:

- a. Determine the need for training. (Will the trainees be employed upon completion?)
- b. Determine what skills the trainees need. (Are the objectives of the proposed program compatible with the needs?)
- c. Determine the potential trainees. (Are there sufficient people who want and could take the proposed training?)
- d. Appraise each applicant's suitability for training. (Who can pretest and evaluate an applicant's entry behavioral characteristics?)
- e. Determine the resources available for training. (What arrangements need to be made for facilities, equipment and instructors?)
- f. Determine the proposed time table and schedule. (How will the inputs be coordinated for maximum utilization?)
- g. Train the instructors, assistants and group leaders. (How will training be given to the instructional staff?)
- h. Assemble the trainees and get them off to a good start. (How will rapport be established and proper motivation and incentives provided?)



- i. Pretest trainees before each lesson to determine entry knowledge. (How will instruction be individualized to meet the needs of each trainee?)
- j. Conduct structured learning and training in a suitable environment. (How will trainees be actively involved in the learning process?)
- k. Assess each trainee's progress during training. (How will individualized instruction be used in correcting deficiencies?)
- l. Repeat steps "i through k" until all training is completed. (How will instructors ensure that all training objectives are met?)
- m. Conduct the final evaluation on behavioral objectives. (What kind of performance tests will be used to measure the trainees' mastery of the course objectives?)
- n. Certify successful trainees as Qualified Basic Tractor Operators. (What standards will be used for certification?)
- o. Assist the local employment service in placement of graduates. (What procedure will be followed in establishing trainees in suitable jobs?)



- p. Assess the success of the training program in meeting community needs. (What type of follow-up and evaluation program will be carried out in self analysis?)
- q. Revise and modify the training program as required. (How can the training be improved based on feedback from instructors, trainees, employers and others?)

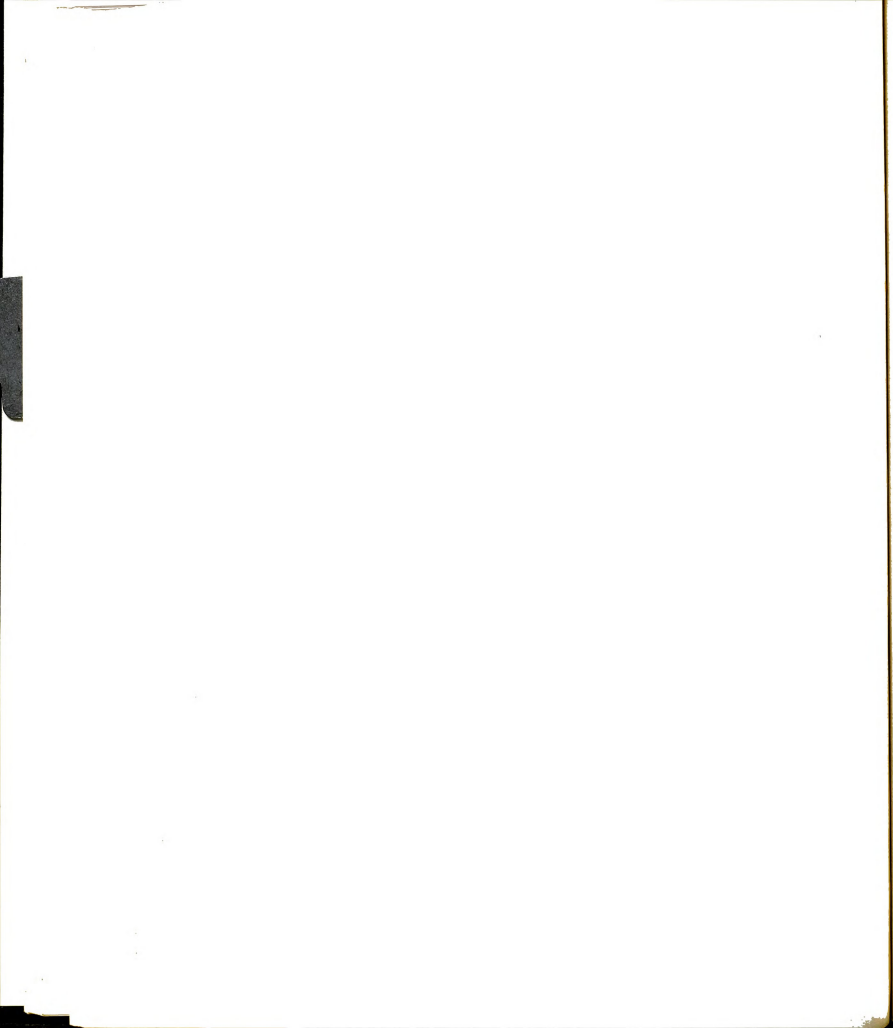
A Suggested Training Course for New Instructors

The format for a special course of instruction for all first-time teachers selected to conduct the Basic Tractor Operators' Course was prepared in outline form. Every instructor must be trained in effective methods of teaching if the training program is to succeed.

The Suggested Training Course for Instructors was built around a one to two-week program as follows:

First Week

- I. Forward, Background, Need and Orientation
- II. Objectives of Training
- III. Assessing the Trainees Background
 - A. GATB or Similar Aptitude Tests
 - B. Personal Interview
 - C. Enrollment Form
 - D. Using Lesson Pretest Evaluations
- IV Trainee Selection (interviews and pretests)



V. Using Lesson Materials (large group sessions)

- A. Introduction
- B. The Course Outline
- C. Behavioral Objectives
- D. Trainee Information
- E. Instructional Methods and Materials
- F. References and Sources

Second Week

VI. Supervising Trainee Activities (small group sessions)

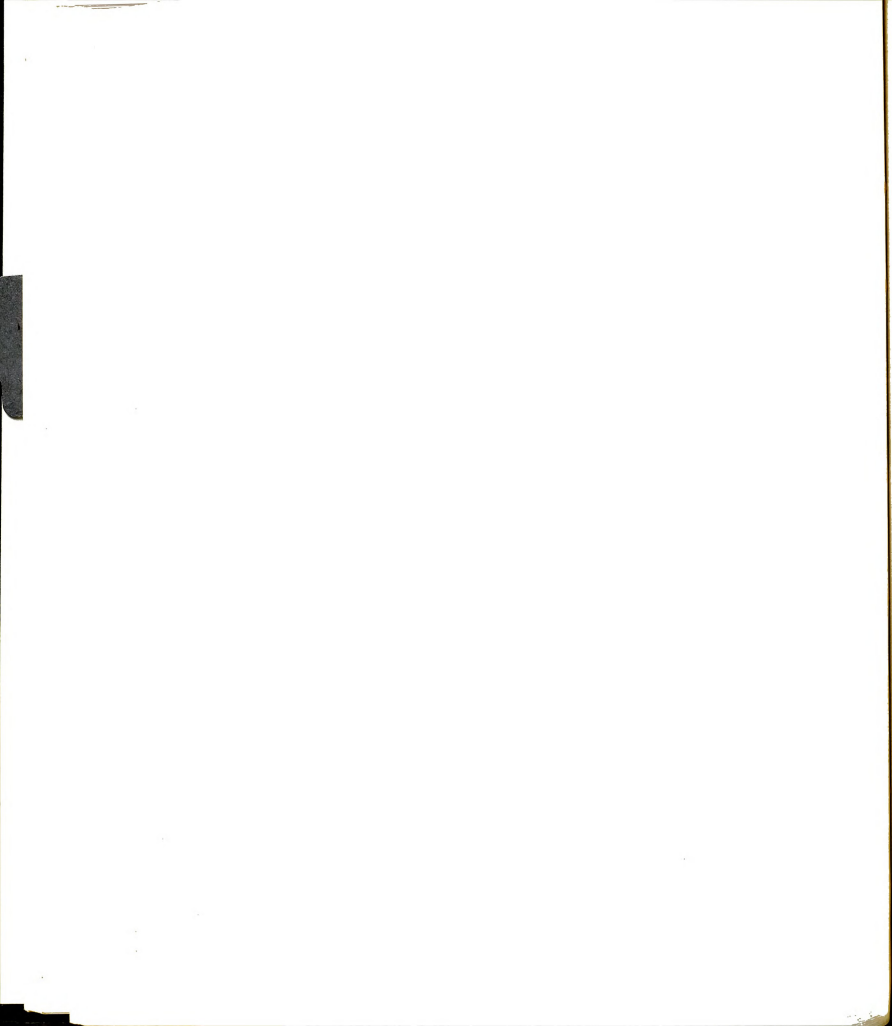
- A. Introduction
- B. Preconditions
- C. Instructions to Trainee
- D. Checklist
- E. Flow Charts

VII. Recording Trainee Daily Progress

- A. Using the Trainee Evaluation Forms
- B. Using the Post-Test Evaluation

VIII. Final Trainee Evaluation

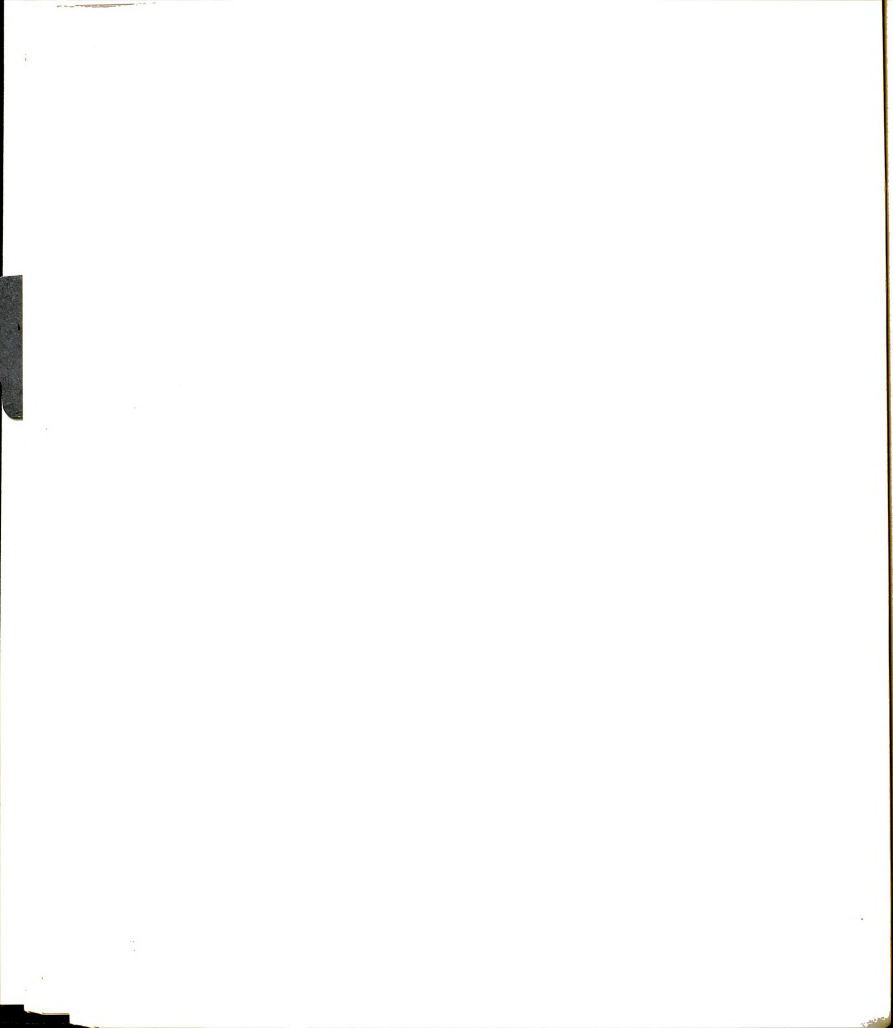
- A. Conducting the Evaluation
 - 1. Driving Skills Course
 - 2. Flow Charts
- B. Using the Evaluation Form
- C. Qualification and Rating
- D. Certification



Using the "Instructor's Manual" as a Guide and Reference.--The responsibility for a successful and useful training program was placed primarily with the administrator and/or the instructor. The "Instructor's Manual" presented a series of carefully researched guidelines to be followed in setting up and conducting effective learning situations for disadvantaged trainees. Such trainees often have very different value systems and experiences, and vague concepts of work discipline. One crucial issue was the development of proper attitudes concerning the need for preventive maintenance of machinery and a cost-to-benefit consciousness.

As a guide the "Instructor's Manual" was not designed to be read verbatim by the instructor to the trainees. The instructor was encouraged to involve the students as early and as much as possible in "hands on" learning "by doing" experiences throughout the training program.

The effective instructor made full use of the guidelines in teaching his assistants and using them to put on skits, demonstrations and practical exercises. As the training coordinator, the master instructor planned thoroughly, informed his assistants of their responsibilities, made full use of available resources, and enlisted the help of business, industry, government and education leaders. He also continuously evaluated



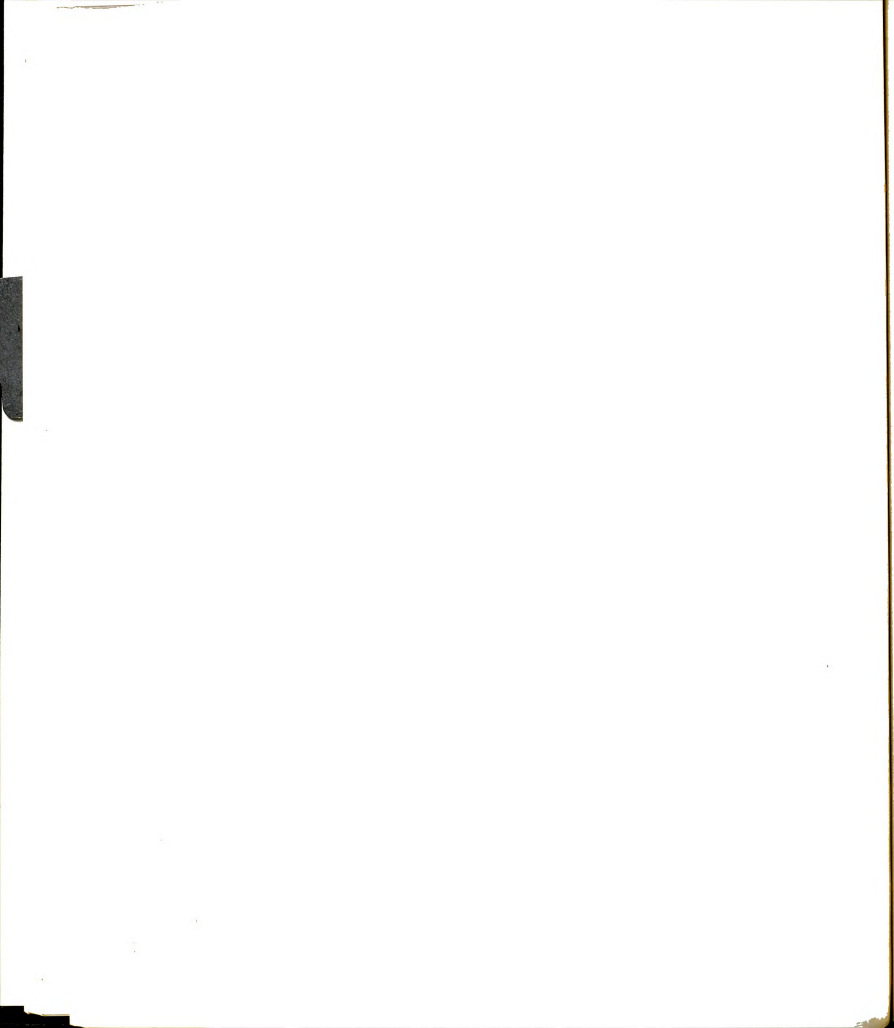
his own effectiveness and his assistants, and constantly assessed the progress of the trainees, counseling them as needed.

Evaluating the Learned "ASK" Attained by the Trainees.--The following concept was developed for the training of instructors charged with conducting the structured learning and training environment designed to impart sophisticated skills and attitudes to unsophisticated trainees.

Instructions to Instructors and Training Assistants: This training program consists of a series of lessons, activities and evaluations designed to help you effectively train unskilled people to become qualified farm tractor operators.

The goals of the training program are stated as behavioral objectives which will change the individual lives of the trainees. The activities are selected to help the learner perceive and achieve each behavioral objective. The evaluations are based on crucial activities to be performed by the trainees to see if they understand and have mastered the stated behavioral objective. The evaluation centers around carefully defined and measurable behavioral objectives to determine the degree the trainee has developed the desired attitudes, skills and understanding.

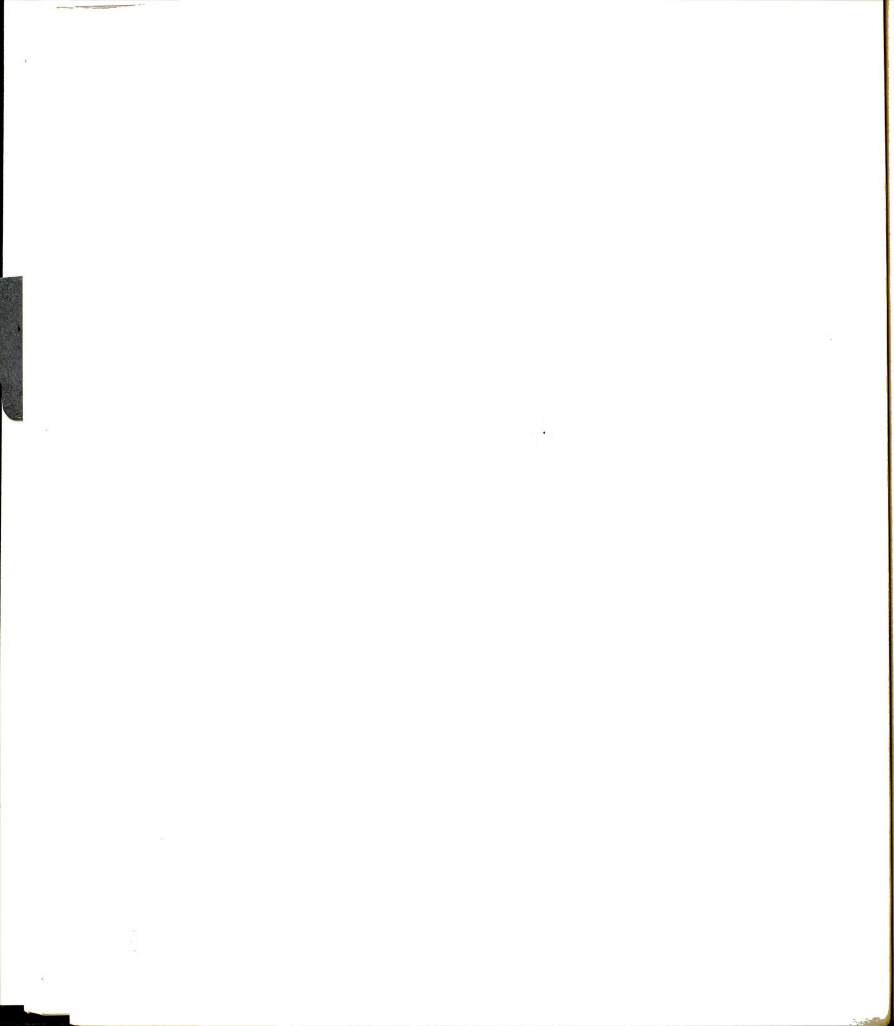
The evaluation is a continuous process starting before orientation and continuing after the completion



of the formal training course. As an instructor, you are most concerned with the daily evaluation before each lesson, during each lesson and after each lesson. You are also expected to help with the final evaluation at the end of the course.

The first lesson in each task cluster (such as A-1, B-1, etc.) contains brief instructions to you and the trainees. Refer to this first evaluation form if in doubt what to do. Record each evaluation as it is made for each trainee. Do not try to wait until the end of the day and jot it down from memory. Base each evaluation on what the trainee actually does or says at the time of testing. Do not let past performance, personal bias or prejudice influence your rating. Rate each trainee on attitude, skill and knowledge based on his performance and response.

To simplify the evaluation procedure, you have been given an extra set of the "Trainee Activities" sheets and a clipboard. Place the "Trainee Daily Lesson Evaluation" form for the lessons to be evaluated on the clipboard first. Put the "Trainee Activities" sheets for the lessons being evaluated on top of this. In this way you can maintain control of the situation, even on a windy day in the field. The loose end of the "Trainee Daily Lesson Evaluation" form can be held down on the clipboard with a rubber band so it is easy to write on as

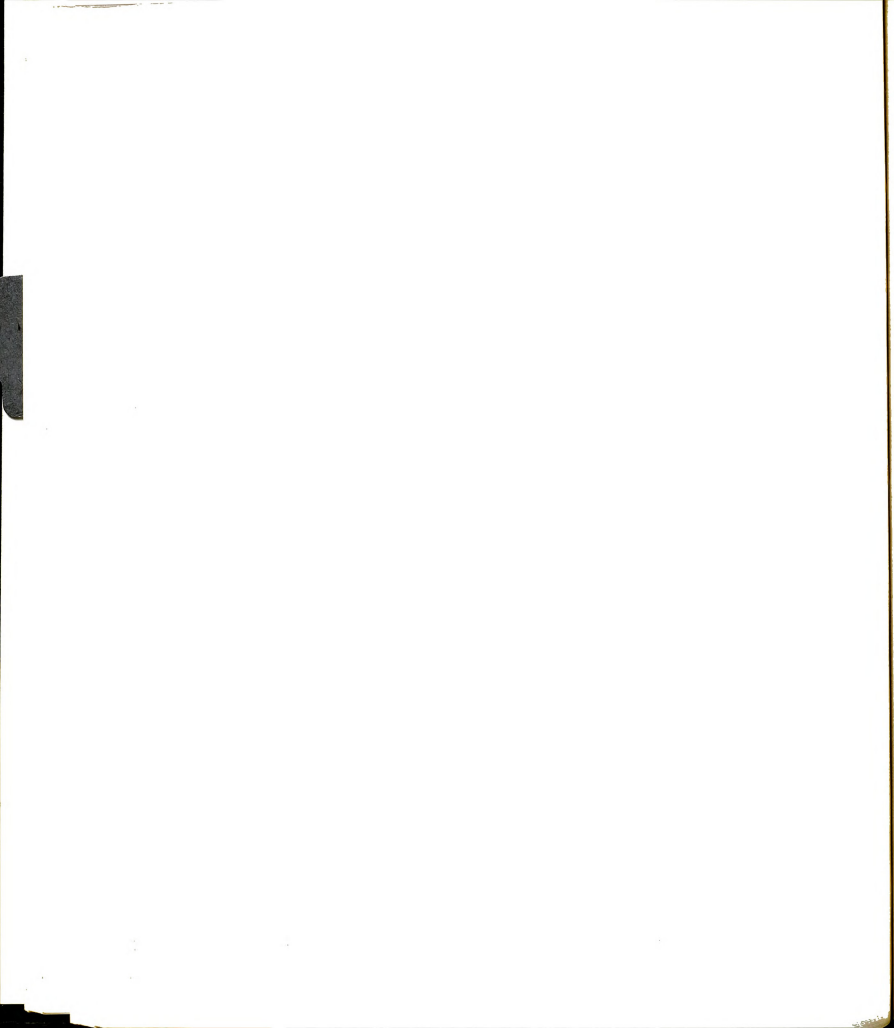


you lift up the questions on the "Trainee Activities" sheets with your non-writing hand. For easy-to-view exercises, the "flow charts" can be used and each item checked right or wrong as the trainee performs the task. In this way you will be sure the trainee does all steps in a logical and systematic way without leaving any out.

For the final evaluation, each trainee will be responsible for all the starred (*) items, so these should be stressed throughout the training. Opportunity must be given to each trainee to answer as many of the questions as possible and to perform each critical skill himself, sometime during the small group activities and practical exercises.

Using Teaching Assistants or Small Group Leaders

A Place for the Para-professional.--In vocational-technical education there is an increasing demand for professional or technical teachers. Many potential instructors in a community may not be trained as teachers, but can be readily trained in the art of teaching. This was done in the Basic Tractor Operators Course by selecting and providing them with the opportunity to attend a training program for instructors designed to fulfill their requirements. Many people, although skilled in their particular craft or trade, cannot provide the necessary guidance and learning experience needed by the learner to become qualified. Moreover, the training program needs



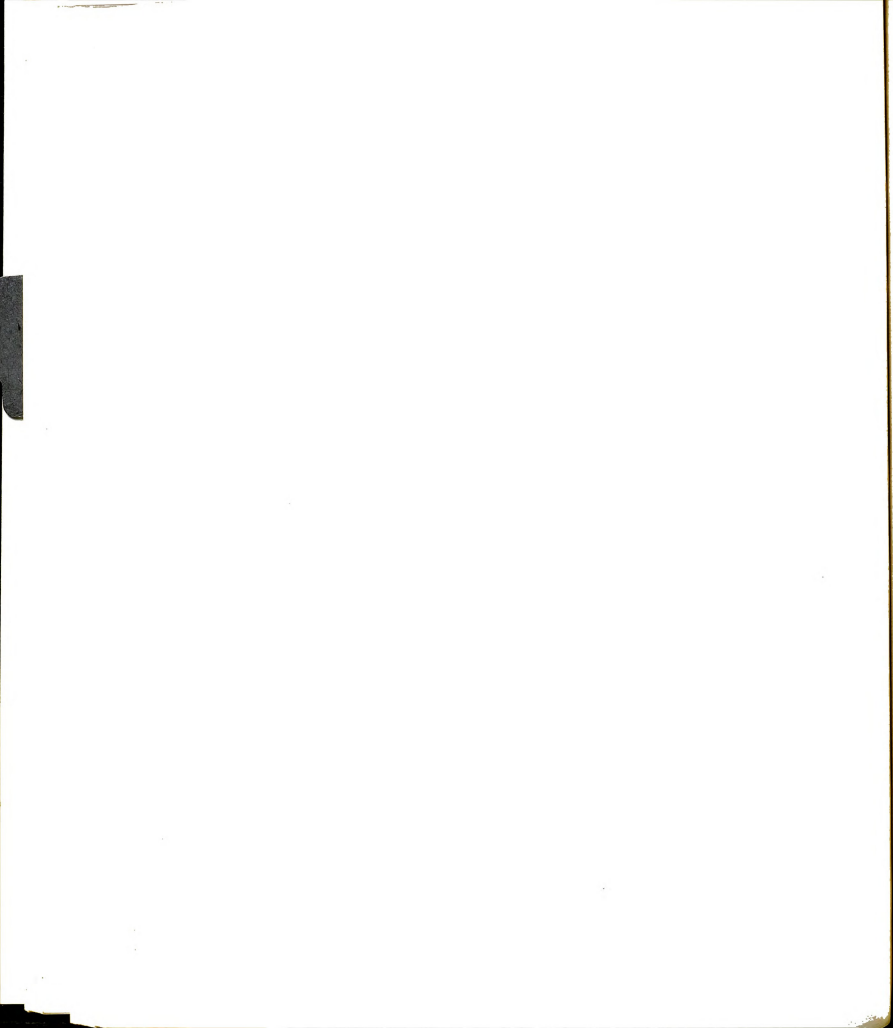
to build good will and cultivate the friendship of the entire community.

The Belding Course for Adult Migrant workers was held on the farm of the chief instructor, Dr. Edward Hotchkiss. He was paid a flat fee for the use of his land to provide realistic training. The land was in the Soil Bank and after plowing, harrowing and dragging, it was reseeded to a legume cover crop. Since these trainees were being groomed to work on Michigan fruit and vegetable farms, they also received some familiarity training on orchard sprayers, dusters and rotary mowers.

Observation and Suggestions
Based on the Belding Pretest
Program

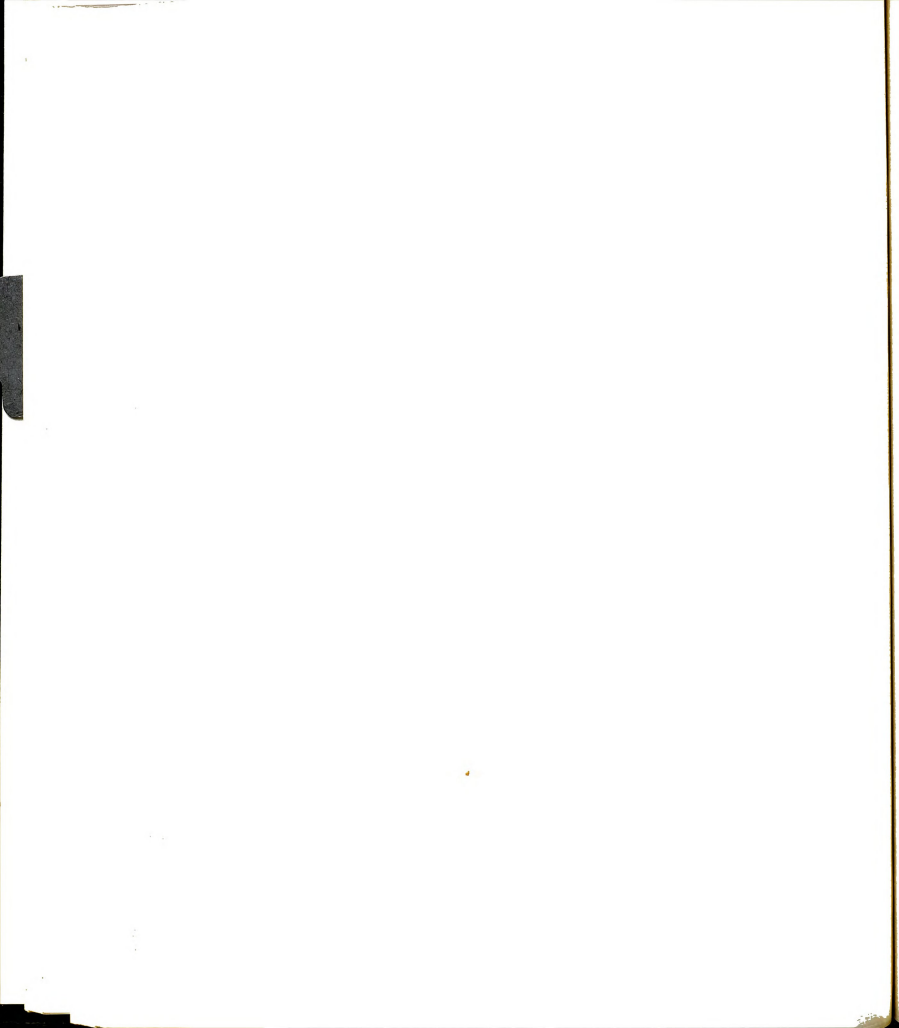
Identification of Trainees Desiring Training.--

An unexpected problem with migrant workers was the spotty attendance of certain trainees and a rather extensive turnover. Since the United Opportunity for Migrants, Inc. made the request for the training course and guaranteed a minimum number of trainees and their regular attendance, there was little that the instructor or the cooperators could do to improve attendance. Some of the initial trainees left about half-way through the course to take jobs as tractor operators in Texas, New Jersey, New York and Michigan. They were not certified or recommended in any way by the sponsors of the training program. Nevertheless, the mere fact that they had attended the course



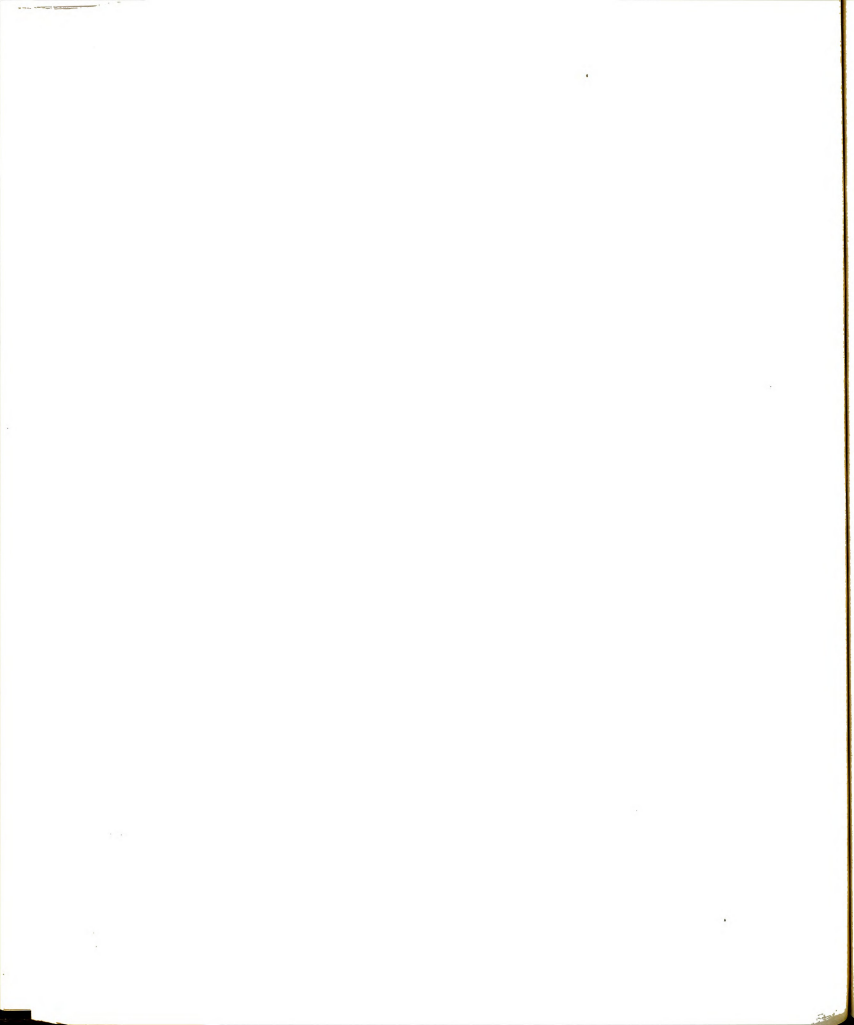
for four weeks half-time was enough of an advantage to enable them to get better jobs. Perhaps it should be brought out here that one of the intangible benefits of such a program of MSLATE training is that it helps the trainee develop confidence, to be able to relate to his employer and to express himself more clearly and positively.

Before a training program is initiated in a community potential trainees must be positively identified. Trainees must guarantee that they are sincerely interested and will attend once the course is offered. An organizational meeting for all interested applicants is a good way to accomplish this. Following this meeting, all applicants should be asked to attend a second meeting to take general aptitude tests such as the Michigan Employment Security Commission Test called the General Aptitude Test Battery (see Chapter IV, pages 189-194). Those who are serious will take the tests and those who are not can be dismissed from the list. At this or another meeting the trainee applicants should be interviewed to get a complete picture of their background and potential. Based on the aptitude tests and the interview, the Training Program Selection committee can select those whom it feels would benefit most from this training. The needs of the individual trainees should be considered, as well as those of the community to which they plan to return after training.



Instructors Must be Trained Before Teaching the Course.--Of all the lessons learned during the pre-test, the most significant was that any instructor, regardless of his qualifications, must receive special training to do a satisfactory job of teaching low-education level trainees. Degrees and past or present teaching experience are not enough. The instructor must be taught how to use the Instructor's Manual as a Guide and not as a crutch. This can be effectively done only by putting the would-be instructor through a carefully structured Instructor's Training Program as outlined on page 238-239.

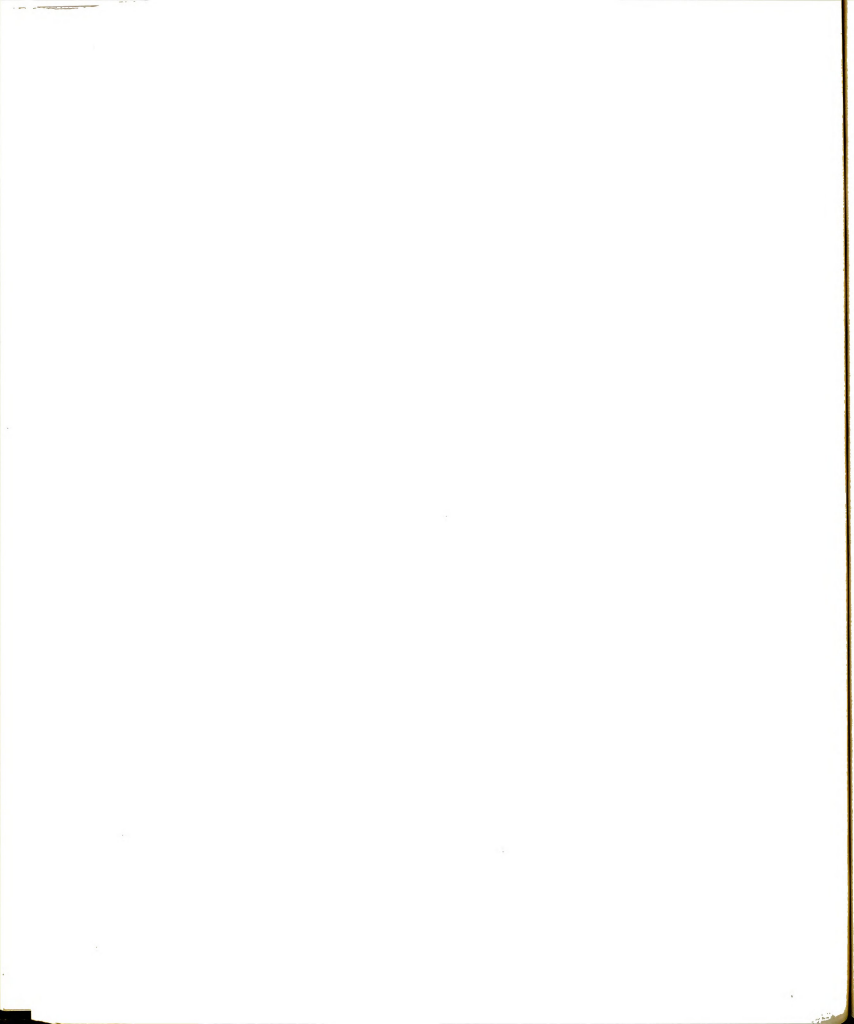
The instructor selected to teach the Belding Basic Tractor Operator's Course for Adult Migrant Workers was sent to MSU to work with the course developers and received this basic training. It was not adequate, however, since he himself did not actually get up and go through a series of representative lessons as if he were teaching it. As a result the instructor did not prepare adequately before trying to teach each lesson. He depended on the Manual too much, even going so far as to simply read it. Very few demonstrations were prepared ahead of time nor did he follow the suggestions for visual aids and demonstrations. Slides were shown sometimes without previewing or planning for their use. In short, he could have done a much better job with more preparation. In spite of all the short comings in the "large group" presentations, the trainees learned because



of the effective way the "small group" activities were carried out by the instructor and his assistants.

The Program of Training Must be Well Organized and the Plan Followed.--Because of the initial spasmodic attendance mentioned above, the instructor was always having to go back and bring those who were previously absent up to date. In extremes the attendance varied from 17 one day to five the next, and this raised hob with the training program. Part of the problem was that half-day sessions were held on three days a week, and a full day was scheduled on Saturday (to which many of the trainees did not come) to accommodate the instructor. Some trainees said they worked, others said they had other things to do on Saturday. Others simply did not want to make the effort to come or said they had no transportation. It is better to have the training scheduled every day rather than skipping a day in between, and to have it either in the morning or the afternoon but not mixed. However, part of the volunteer instructors could not come on certain days due to a conflict with their regular jobs.

Since a large amount of material must be covered systematically the instructor must follow a plan. Otherwise he becomes lost in detail, irrelevant or too advanced material, and never clearly identifies the key points a basic tractor operator must know nor the skills he must



learn. Without a definite plan and schedule he will also lose track of the evaluation and abort most of the pre-testing, post-testing and daily evaluation which otherwise keeps him informed. The sequence of the lessons was carefully worked out and should be followed unless the instructor has a cogent reason for making a change.

The time it takes to cover any lesson will depend on the knowledge and skill level of the trainees at the beginning of the lesson, the extent of the language barrier, the rapport that exists between the instructors and trainees and how well prepared the instructors are to provide the best learning environment. The number of hours needed to cover the course is given in Table 5.1. The low figure is for more advanced trainees working under more favorable conditions with experienced qualified instructors. The higher figure is estimated for lower-level trainees being taught by a first-time or mediocre instructor under less than ideal conditions. The Belding preliminary test fell half way between these figures and took about 160 hours.

Suitable Equipment Must be Available.--Sufficient equipment must be provided in good running condition so it can be used extensively by the trainees for the practical field experience. Sometimes the trainee's family or employer furnishes the tractor he will be trained to use. Ideally this would provide each trainee with a

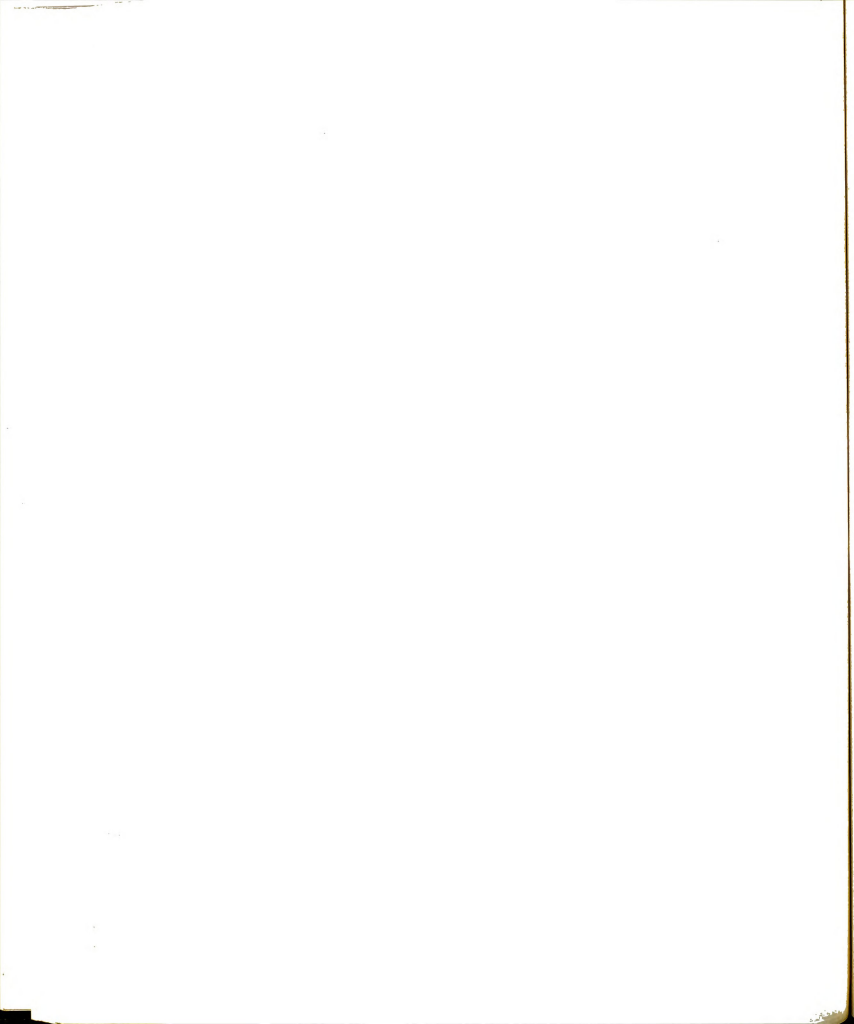
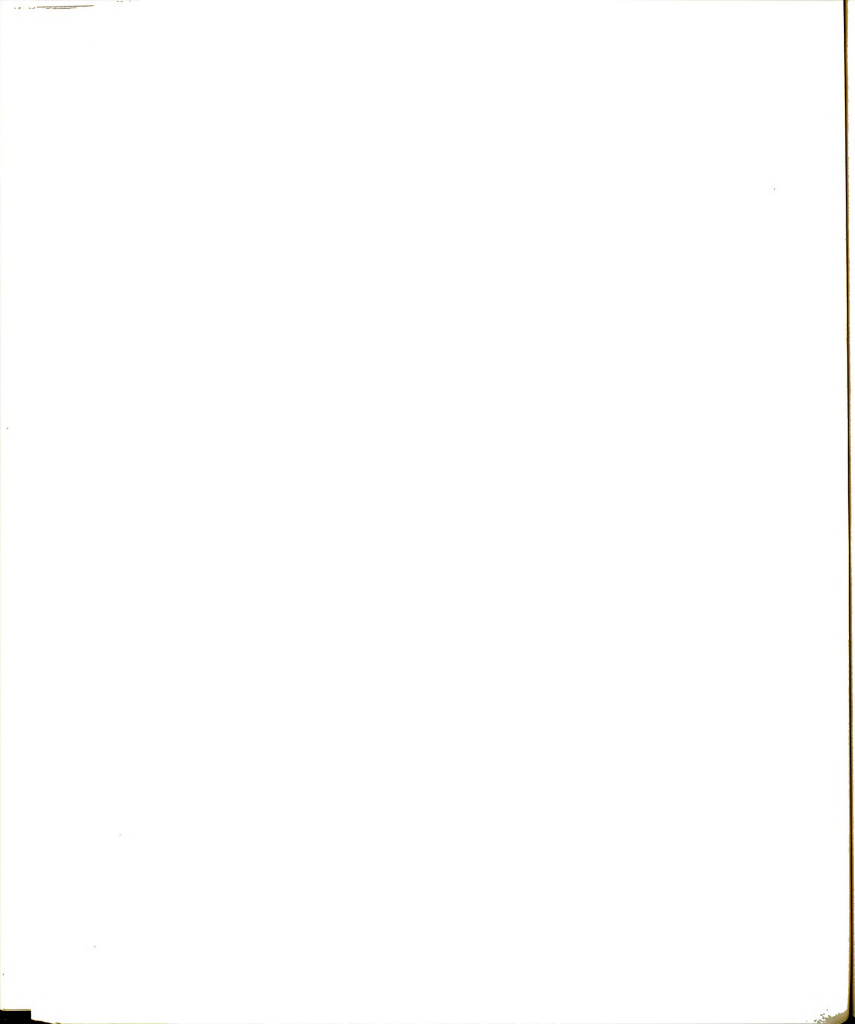


TABLE 5.1.--Estimated number of hours to train a Basic Tractor Operator, Grade I.

Chapter	Major Topics	Estimated Hours of Instruction	
		Minimum*	Maximum**
A.	Getting acquainted with the tractor	8	12
B.	Getting the tractor ready for work	28	40
C.	Starting and warming the engine	8	12
D.	Operating the controls and maneuvering the tractor	14	30
E.	Managing the tractor and using good judgment	8	16
F.	Using the tractor as a power source and prime mover	8	16
G.	Emphasis on safety considerations	3	4
H.	Using the tractor with implements in productive farming operations	32	64
TOTAL Number of Hours		109	to 196
Approximate Number of 8-hour Days		14	to 24
Approximate Number of 6-hour Days		18	to 33
Approximate Number of 5 Day 40-hour Weeks		3	to 5

*Above average trainees

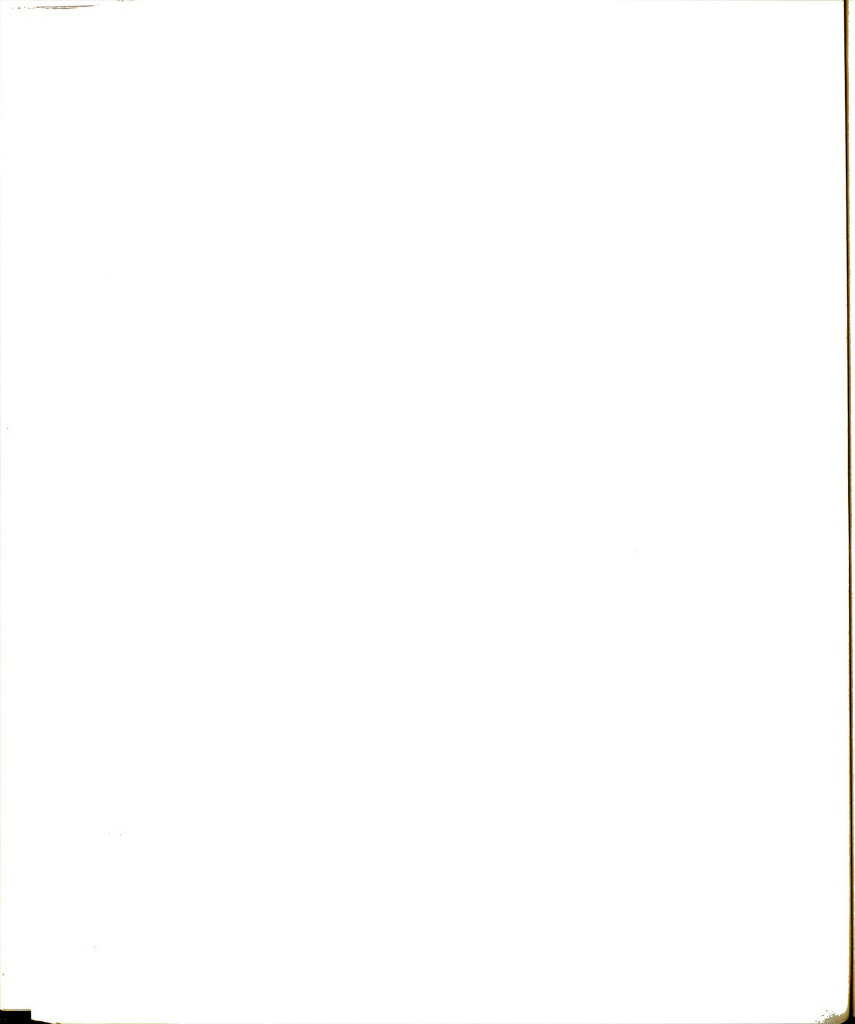
**Below average trainees.



machine for which he alone would be responsible. In cases where the Agricultural Development Bank or similar agency is planning to loan the applicant a sum of money to buy a tractor, they may make it contingent upon the fact that the applicant provides proof that he has passed some type of mechanization training program, or, that he be enrolled in such a course and graduate before he receives the loan to purchase the tractor and associated equipment.

In this preliminary test new tractors were rented to supply one tractor and basic tools for each group of five trainees at the Belding Adult Migrant Worker Tractor Training Program. During the eight weeks of half-time training, the trainees put 49 to 51 hours on each of the three tractors. Most of this was put on during the last two weeks when the trainees were operating the tractors and implements daily to gain field experience.

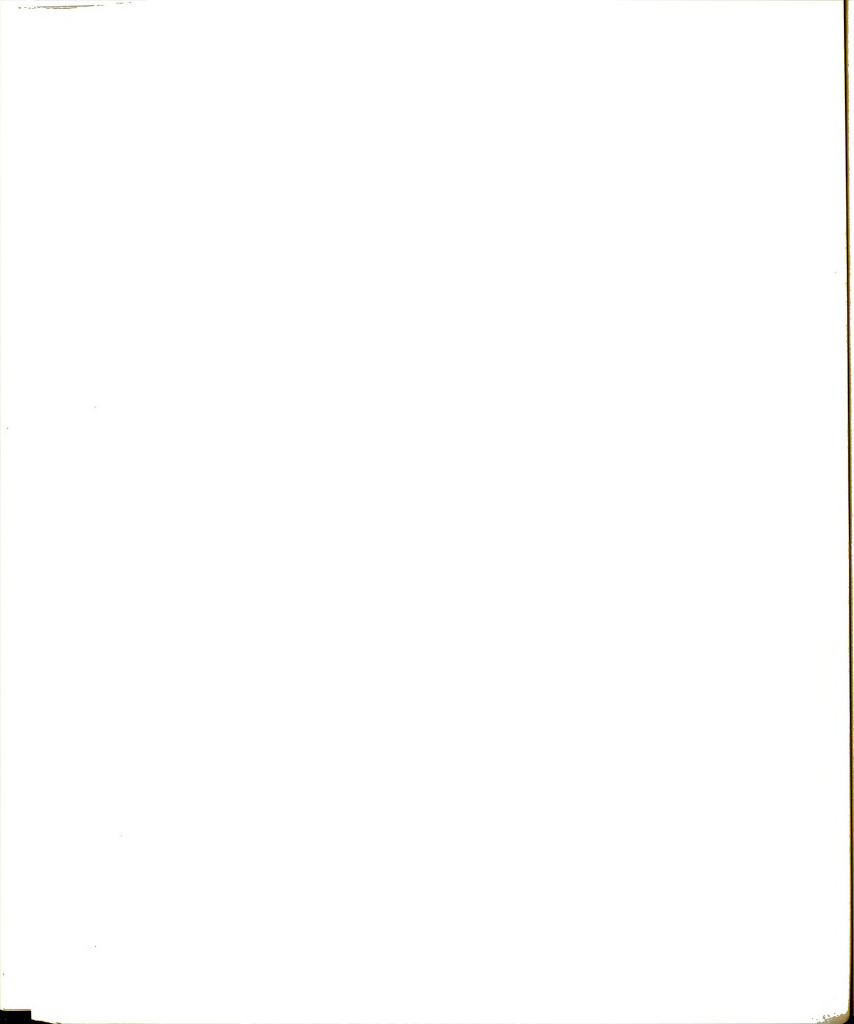
As far as learning the skills and procedure to follow in performing the daily pre-operation service checks and the weekly maintenance checks, it would be better to have good used tractors rather than brand new machines for the trainees to work on, take care of and maintain. The used tractors and machines are less expensive and more readily available in most communities. The cost/benefit ratio would be more favorable and defensible when expanding the training program



for more less-advantaged persons. The implements, of course, should be typical of those commonly used in the country or region and must be in serviceable condition (see Chapter III, page 153).

Facilities Must be Conducive to Learning.--For effective learning the training physical environment must facilitate the presentation by the instructors and retention by the trainees of the essential facts and skills. The trainees must see and hear easily, be reasonably comfortable so they can concentrate on what is being studied and not be distracted by outside audio or visual competition. The assignment of not over five trainees to a small group is essential if each trainee is to be able to see what the instructor is doing at all times around the tractor. The small groups should be far enough apart so that the noise and movement of one does not affect the others.

If trainees are too uncomfortable they lose interest and may not even return the next time. The building or shed must not be too hot or too cold, too dark or too bright, too stuffy or too windy. In the pre-test migrant program held in early spring, the barn was too cold and windy and the trainees were not adequately dressed. Fortunately, a one-room "standard country school" was nearby where large group presentations were made. A portable heater was used but the fan made so

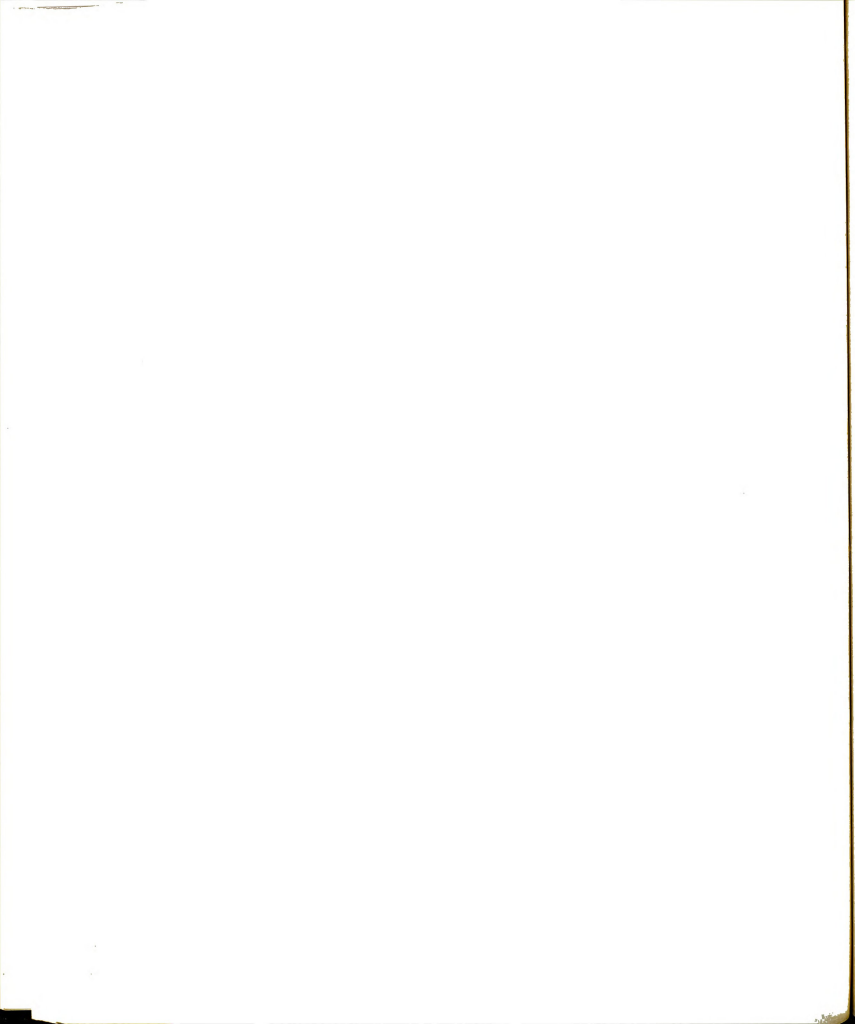


much noise that it had to be turned off during the large group sessions to hear the instructor. The fumes from the unvented heater also gave some of the trainees headaches. In the summer, bright sunlight and heat will be a problem unless the class is held under a shaded building and curtains can be drawn. If slides or film-strips are to be shown, the windows must be darkened.

If the trainees want to take notes and if they are to fill in the answers for the pretests and post-tests, they will need a small writing arm chair or a table. Hot coffee and bread or rolls at the longer mid-morning break helped refresh the trainees. Many of them apparently did not eat an adequate breakfast.

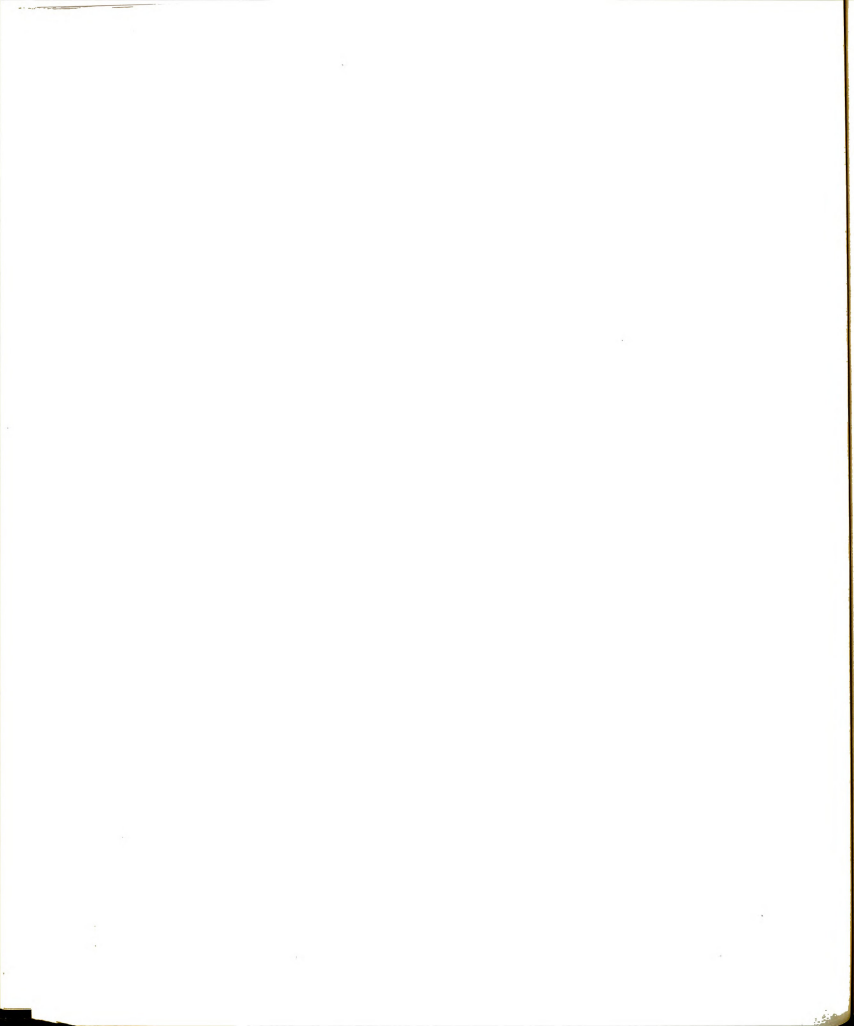
Adequate light for dark days or during rainy weather is necessary to maintain training efficiency. For safety, only electric lights should be used. Since part of the servicing and maintenance activities will involve fuel and solvents, no smoking should be allowed and no flame-type lights or heaters should be used around the tractors. The instructor must make sure there is adequate ventilation for alertness and that tractors will not be run unless doors or windows are open or the exhaust is piped outdoors.

The Timing and Scheduling Must be Acceptable to the Trainees.--Generally a training program should be held during the off-season or just before the land



preparation season. If trainees are working, the school must be fitted around their schedule. Many employers will grant some time off to take more advanced training and some will even pay the trainee his regular wage or a stipend. For unemployed migrant laborers the State of Michigan paid a small stipend to encourage them to go on and to offset some of the cost of transportation. Several trainees had to travel up to 60 miles one way to attend the school.

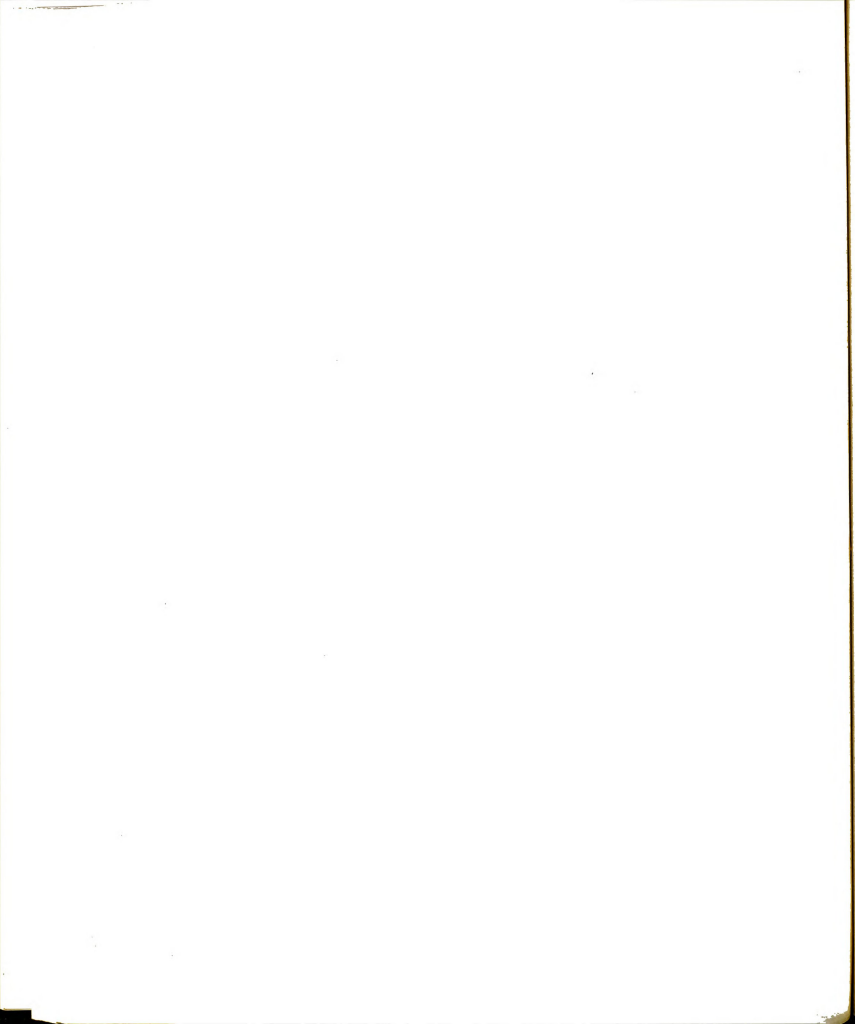
The first two weeks, in fact, the attendance was very spasmodic and generally poor. Although the trainees were supposed to team up and ride together this did not seem to work. Finally, all trainees were asked to report to a central location in Grand Rapids and were then bused to the training site some 35 miles away, using a small bus from the Grand Rapids School District. Attendance was markedly improved except on Saturday. Trainees were coming on Tuesday and Thursday mornings and Friday afternoons for four hours and then all day Saturday. This should have been the best day but it interfered with the personal habits and weekend shopping of the families. As a last resort the schedule was shifted from Saturday to Monday and Wednesday mornings and from Friday afternoon to Friday morning so the training was held on five consecutive mornings without encroaching on the weekend. After this the attendance improved almost 100 per cent.



The question is naturally raised, why wasn't it done this way in the first place? The answer is that not only must the trainees be considered, but the assistant instructors also had to be accommodated. Some of the assistants and supervisors could not attend mornings because of University classes and their regular work. After the training was changed to mornings, two assistant instructors could no longer help out and the work load had to be doubled for the others since one small group had to be dropped. Some of both was done and it worked out all right since the number of students also dropped from 17 to 12 the last three weeks as several trainees left to take jobs.

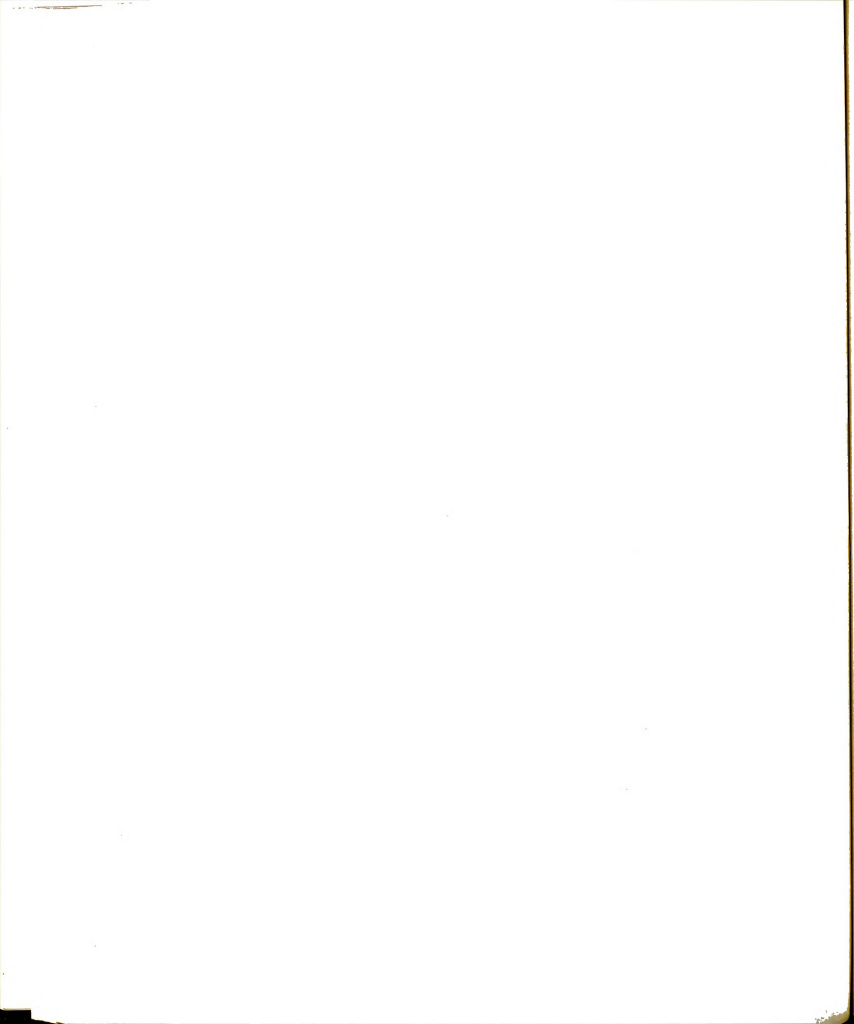
When working with volunteer instructors, in which the work with migrants, etc., is not their main job, schedules must be adapted to get quality instructors. Both of the University students (a junior and senior agricultural engineer) did excellent jobs as assistant instructors. The retired farmers also did good jobs but it took a lot more effort for them to follow the schedule, to keep the records properly, to supervise their trainees constantly and to conduct daily evaluations.

Training Program Responsibility Must be Assigned, Accepted and Agreed Upon by Sponsors, Instructors, Parents and all Cooperating Groups.--For a training program of this nature to be successful, it is absolutely essential that



each cooperator know what he is supposed to do and then to accept personal and collective responsibility to see that it is done. In this case the United Opportunity for Migrants, Inc., was supposed to insure that the trainees wanted the course, that they were committed to it, that they had transportation to it, and that they would be there every scheduled day to take advantage of it. There were many slips the first half of the course and a firm commitment was not accepted by O.M.I. until they were told, in effect, that if the trainees did not start coming regularly, the developers of the course who were also supervising its presentation, would withdraw their support and the instruction materials, thereby cancelling the training program.

The instructors, themselves, accepted a special commitment, especially when they were well paid. In this case the chief instructor was well qualified by virtue of education and experience, with a BS in mechanical engineering and a MS and PhD in vocational education. He was currently teaching mechanics and technical courses as a professor with the Grand Rapids Junior College and also farming part-time in fruit production. Furthermore, he was supposed to be bilingual in Spanish and interested in migrant workers. The sponsors were disappointed in the presentations and effort put forth by the instructor because a much better job could have been done. Perhaps



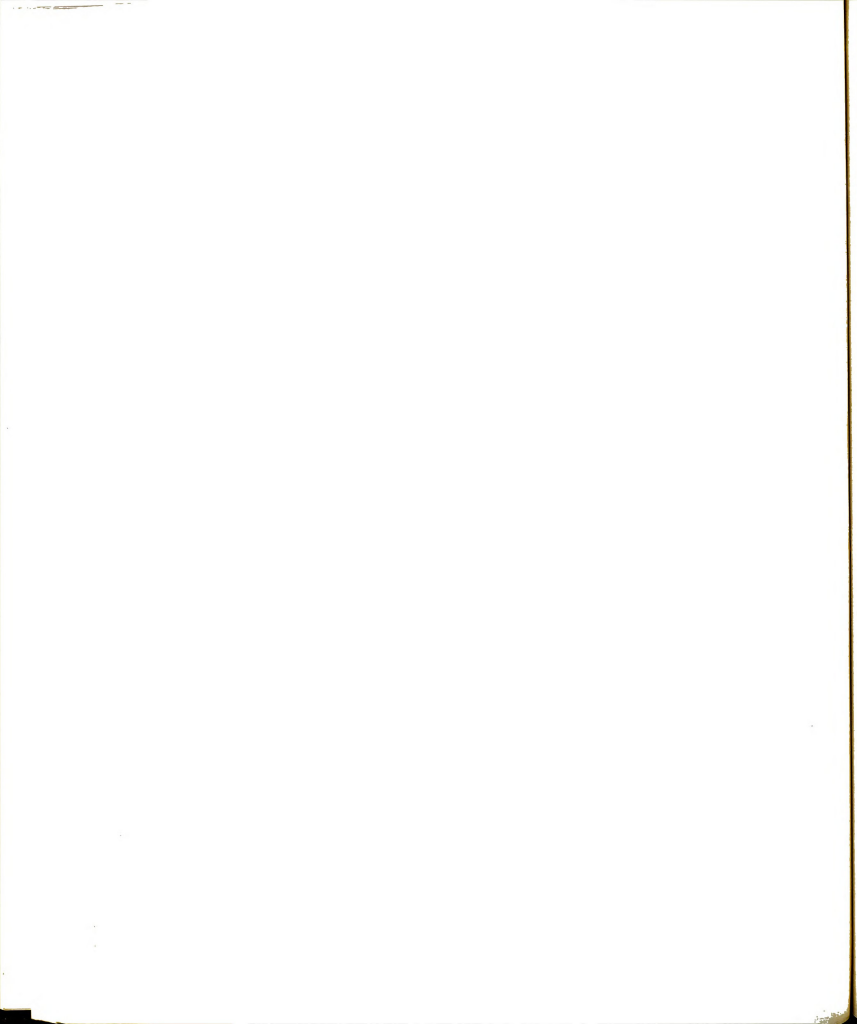
he felt like he "knew it all" but this is no reason for not preparing ahead of time or thoroughly knowing the material. In general the classes were not as well organized as they could have been and there was a tendency to jump the gun and "get them on the tractor" because the instructors correctly diagnosed that the trainees were losing interest.

This re-emphasizes Mosher's statements that "the most important ingredient in an effective training course is a good teacher" and "the trainer has two tasks in a program of in-service training: to design and to manage a learning experience for his trainees" (S. T. Mosher, 1966, pp. 8-9). He points out (p. 11) that

If a trainer has thoroughly prepared in advance he can rely on the printed materials and his individual lesson plans . . . for the subject matter of the course. He can then devote his full attention to managing the learning experiences of trainees by joining with them in learning more about agricultural development, involving all trainees in the process and using a wide variety of different teaching methods.

Pre-entry Characteristics of Migrant Trainees

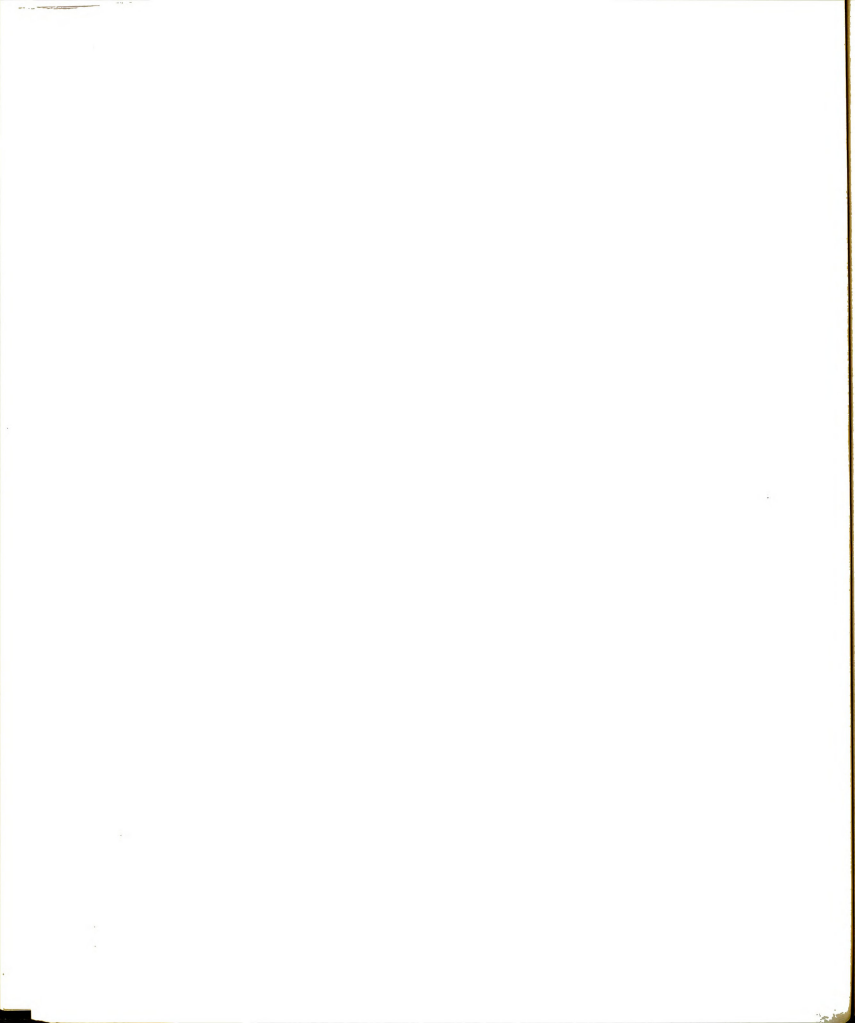
The following information covers only the 12 trainees who completed the Basic Tractor Operators' Course in June, 1970. Most of the trainees were from Puerto Rico and were under 30 years of age. They averaged six and one-half years of foreign schooling except for one trainee educated in the U.S. The trainees possessed no trade skills except carpentry. Half of the trainees had no farm



experience and the others had only limited training as field laborers. Seven had some factory experience of a meager nature while three had worked over a year in industry.

All trainees reported they could ride a bicycle, 75 per cent claimed they could repair it, and 50 per cent had owned one. Since migrant workers must travel from job to job, it was not too surprising that 75 per cent said they could drive an automobile, 67 per cent reportedly were licensed drivers, and 58 per cent claimed they had done some repair work on one. Half of the automobile drivers stated they could also drive a truck, but only one claimed to be able to repair it. Four men stated they had operated a wheel tractor and two men a crawler tractor before training. The other trainees had no familiarity with engine-powered agricultural machinery.

A majority of the trainees wanted to become tractor operators because it was an important job and would give them more job opportunities. Other important reasons were that they liked to take care of machines, to make decisions, to use their hands and to do things in an orderly way. All trainees reported they had used some of the common tools and equipment. The hammer, wrench, screwdriver and hand saw were mentioned most often. Half of the men had used small field tools such as a drill, cultivator, disk, plow and mower.



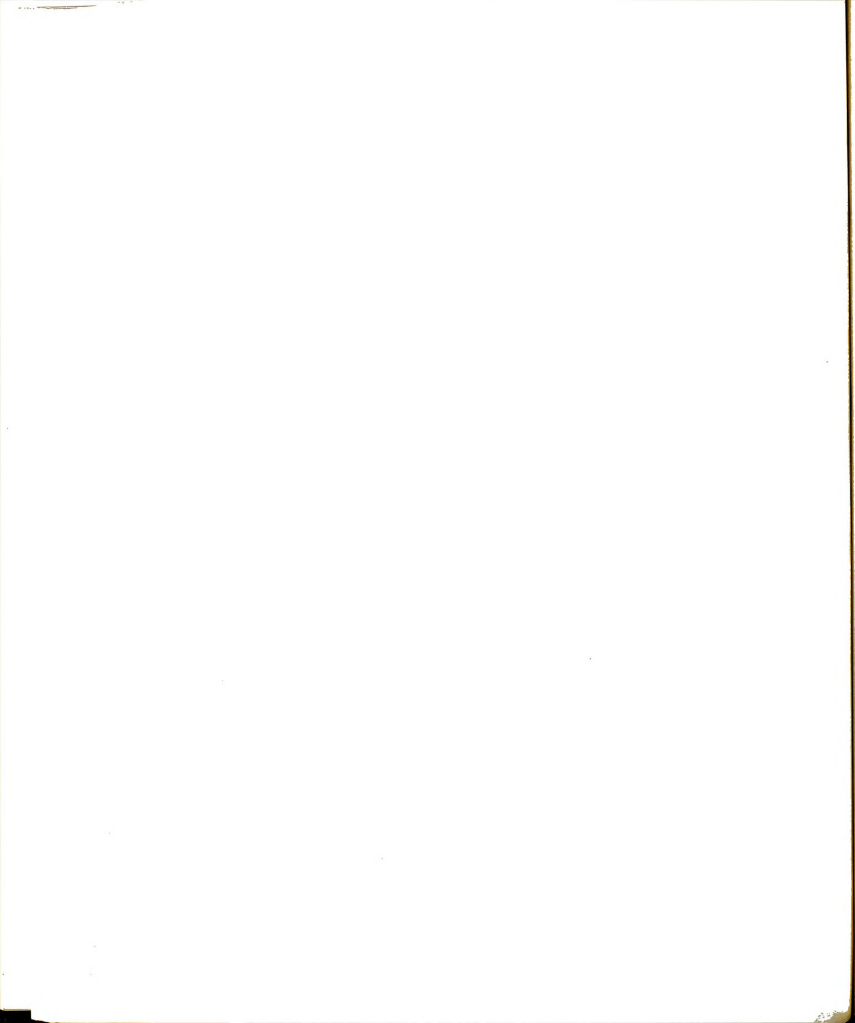
Use of Lesson Pretests and Post-tests

One purpose of the lesson pretests was to measure the trainee's progress during training by comparing his initial attitudes and knowledge with subsequent progress on an identical post-test.

A complete series of pretests and post-tests were not given due to the intermittent attendance at the beginning of the course and because the instructor did not follow the schedule at the end of the course. The validity of the tests is questionable because it cannot be sure the trainees clearly understood the statements or questions they were being asked to answer. Part of this was due to the bilingual difficulty the instructor had in translating the technical terms.

A statistical summary and item analysis was made of each question of the A, B, and C-series pretests taken by the 12 trainees. These comprised 35 of the 65 lessons in the BTO course. The number of trainees taking any one test varied however, due to illness, transportation problems, personal problems and changes in enrollment due to drops and adds. Only half of the 12 trainees attended all training sessions.

The inconsistent level of knowledge indicated by the pretests suggests they may not objectively measure what the trainee knows as he enters training. Since most of the trainees successfully completed the course and were graduated



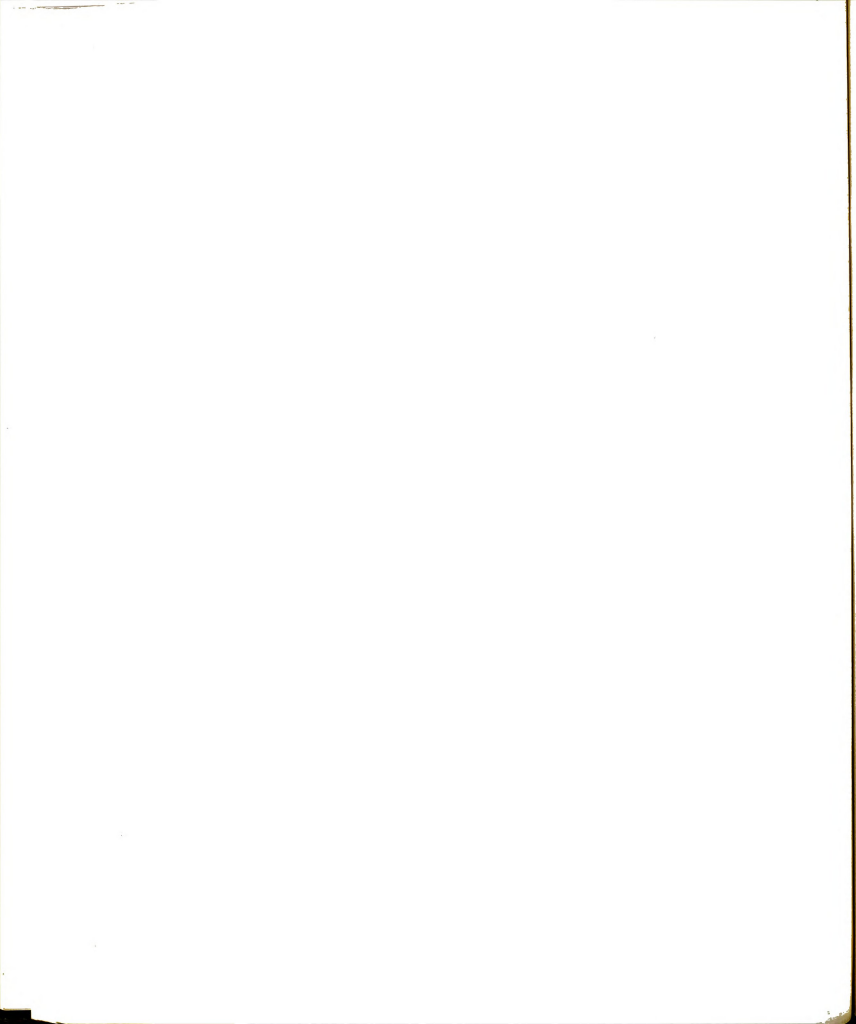
as qualified tractor operators, this also indicates the trainee's entry background is not important in selecting or rejecting trainees based on knowledge or attitudes before training. The measurement of apparent mechanical aptitudes and skills before training is still desirable as a predictor of trainability.

In cross-cultural training it is very debatable that adequate communication takes place in written tests, even with oral explanation, when the trainee cannot comprehend the written language. The communication depends entirely on the instructor's ability and skill in bringing about verbal understanding. Half way through the course, the pretests were stated as questions rather than non-personal statements and this seemed to have more meaning for the trainees.

The value of the pretests and post-tests is not well defined by this initial preliminary test of the BTOC with Spanish-speaking migrant trainees. Incomplete testing made it impossible to compare entry knowledge with training progress as measured by the post-tests. The deficiency in bilingual communication raised serious questions about the trainees' comprehension of the questions and their response to them.

Daily Evaluation of Trainees by Instructors

During the small group activities each instructor reviewed the material presented in the large group sessions

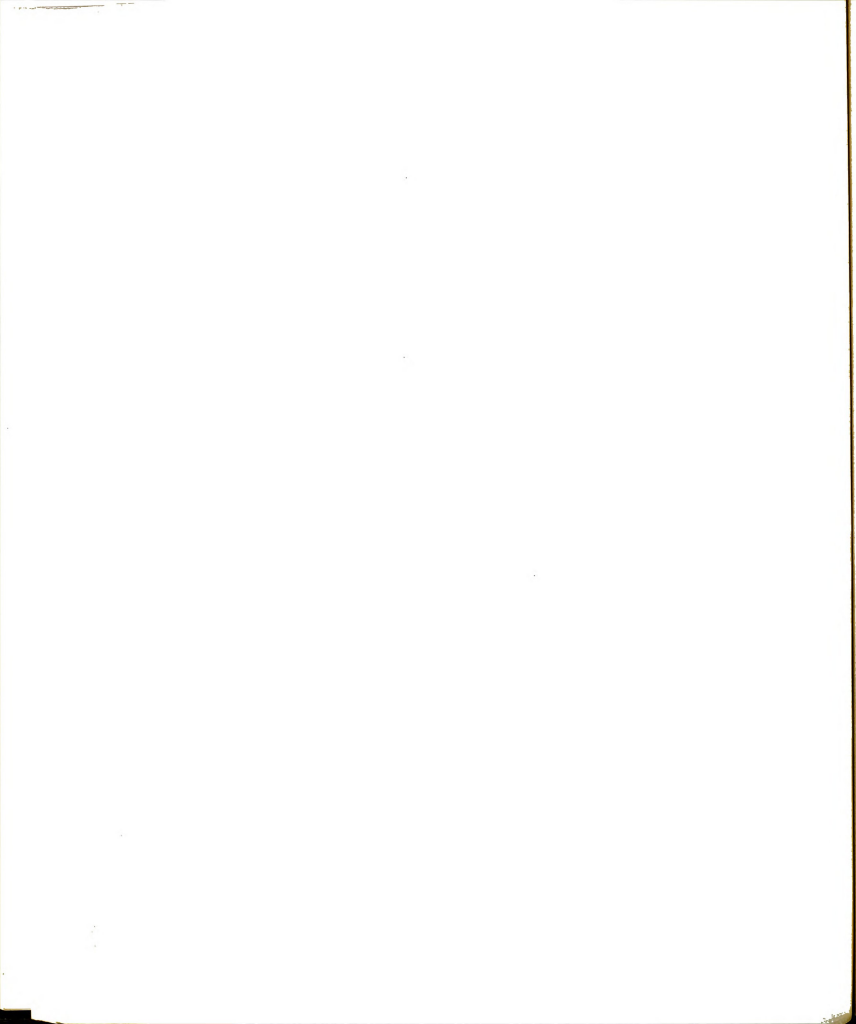


and asked the trainees questions. Then the instructor asked trainees to perform various tasks and evaluated them on their responses to the lesson behavioral objectives. After the lesson was finished, he rated each trainee on his performance using the ASK scale. About one-third of the way through the course, the instructors were familiar enough with the system that it was decided to drop the listing of individual checkpoints and only make the ASK numerical rating from "0 to 3" to simplify the record keeping. It was difficult to get the instructors to keep an up-to-date record on each trainee and to rate them quantitatively after each lesson. The instructors were not to blame, however, because spasmodic attendance of some trainees made teaching and evaluating difficult.

Based on the preliminary field test, daily rating of trainees by instructors is highly desirable. It helps them think through how the trainees are learning and how good a job they are doing in teaching. The system of using "o" for neutral, "-" for negative and "+" for positive attitude; "0" for Unqualified, "1" for Needs More Work, "2" for Qualified and "3" for Superior skills and knowledge worked well in measuring and evaluating trainee progress and performance in meeting lesson behavioral objectives.

Summary of the Final Evaluation of Tractor Operator Trainees

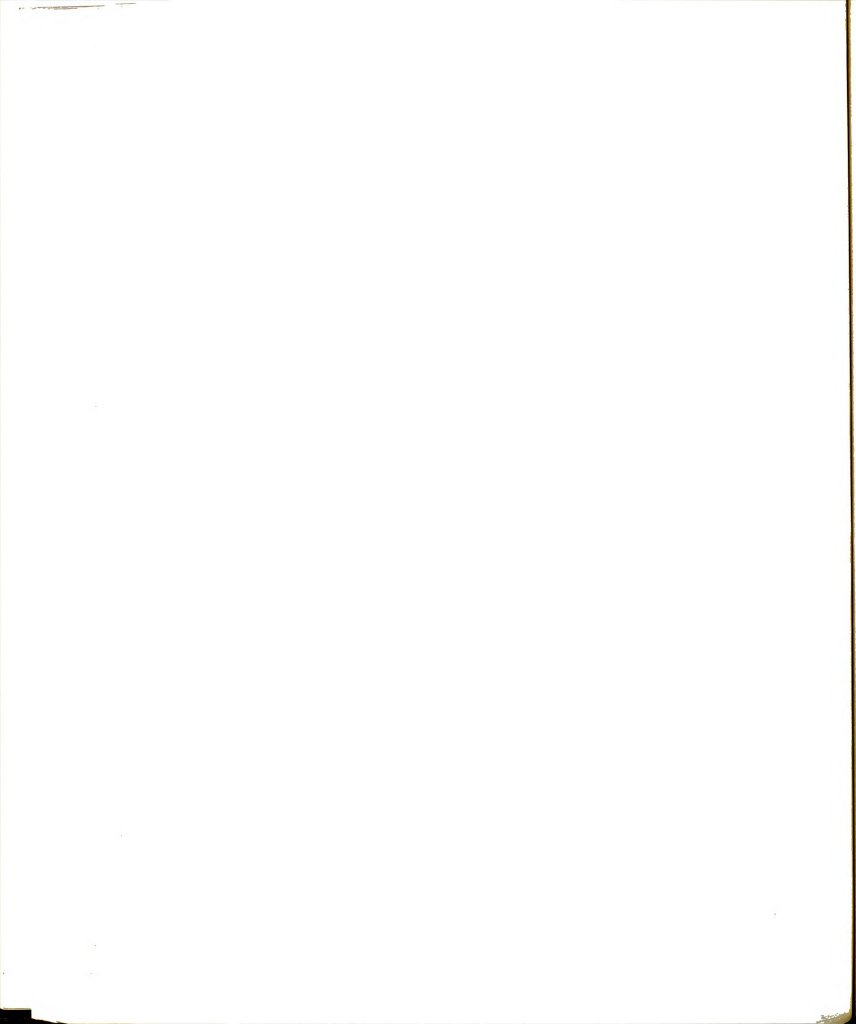
Each trainee was evaluated by outside judges in a series of seven events covering a cross section of the



critical points specified as key behavioral objectives. Six events were performance-type tests of actual work situations in which the trainee was asked to do certain tasks and then evaluated on what he did. Scoring was based on observance of performance and the response to the evaluator's instructions and questions. How well the trainee performed was measured by a time factor and the quality of his work. For each error, omission or sub-standard performance the trainee was assessed penalty points. See Appendix A.

The seventh event was an oral/written test on knowledge and attitudes administered by the bilingual instructor. It consisted of 150 questions selected from the pre-post tests covering the most important points from the 65 lessons.

The scoring scale was absolute although the pass/fail point was determined after the evaluation was completed. Some trainees did relatively poorly in some events and much better in others. The pass/fail point was based on the weighted total score of all events so that an excessive penalty for safety, for example, would not necessarily disqualify a contestant. A total of 3500 points was allowed for the final evaluation with each event having an approximate weight of 500 points. The raw scores for the skill driving event were divided by four while the raw scores of the oral/written test were multiplied by

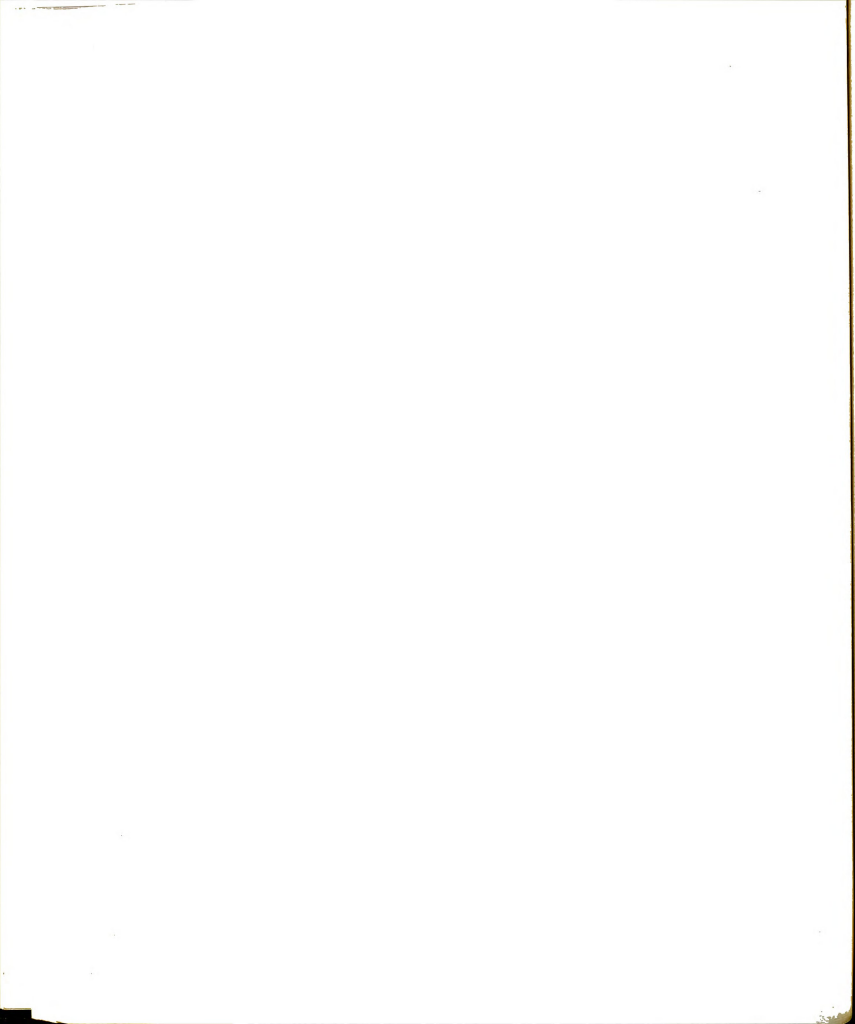


four to give this balance. The adjusted negative raw score for all events was then subtracted from 3500 to get the final positive evaluation score.

By using test feedback the instructor can detect which parts of the course need more attention and possible revision. He should use this information to review his teaching techniques and revamp the lessons as needed. The variable nature of the misses on some parts indicated that both good and poor students had difficulty knowing what was wanted or in misinterpreting the test question.

For small groups of trainees, test item statistics are unreliable. They are also suspect for any new program until it has been taught and evaluated at least three to four times. The MSU Office of Evaluation Services suggests a minimum of 50 students for meaningful results in test analysis. For good results the group should be increased to 100 or more students.

In this preliminary test with 12 migrant trainees, the indicated item analysis cannot be considered a fair indication of the performance of these performance tests. First, it is desirable for trainees to get all questions right on a pass-or fail test for qualification. If the performance test score is absolute, the only passing grade for all test items is 100 per cent. Because this is not realistic in a cross-cultural training program, where communication is often questionable, a lower pass/fail point was established. By studying the item analysis, it is



possible to raise the minimum acceptable absolute score by removing ambiguous or high difficulty items from the test.

With a language problem it is pointless to have more than one option in addition to the correct one in a final evaluation. The trainee must be able to distinguish whether the test item is correct or incorrect because he will be graded on his ability to do the job right in real life.

Certification of Trainees as Qualified Basic Tractor Operators, Grade I

Ten of the 12 trainees were certified as having successfully passed the course to become qualified as Basic Tractor Operators, Grade I. The tenth trainee was conditionally qualified since he made significant progress from his entry level at the beginning of training. Using the results of the Final Evaluation Events, the training staff ranked the trainees and selected a pass/fail point for certification. In considering whether the trainee was qualified, they also looked at the daily training evaluations made by the small group instructor and the progress made during training in achieving the course objectives.

A list of the individual scores for each of the seven final events is shown in Table 5.2. The test scores are adjusted negative scores where the lowest score is best and the highest score is poorest. Under each event the best and worst scores are underlined. The pass/fail point was set at 2300 points out of a maximum of 3500 positive points.

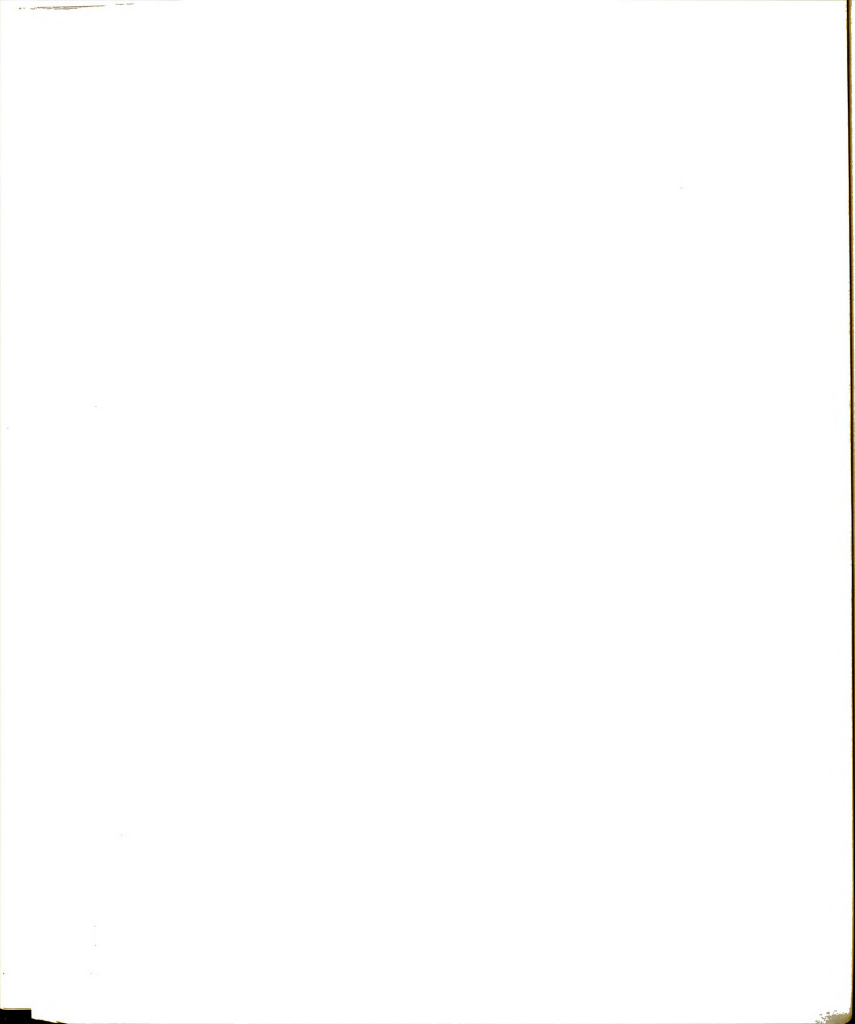
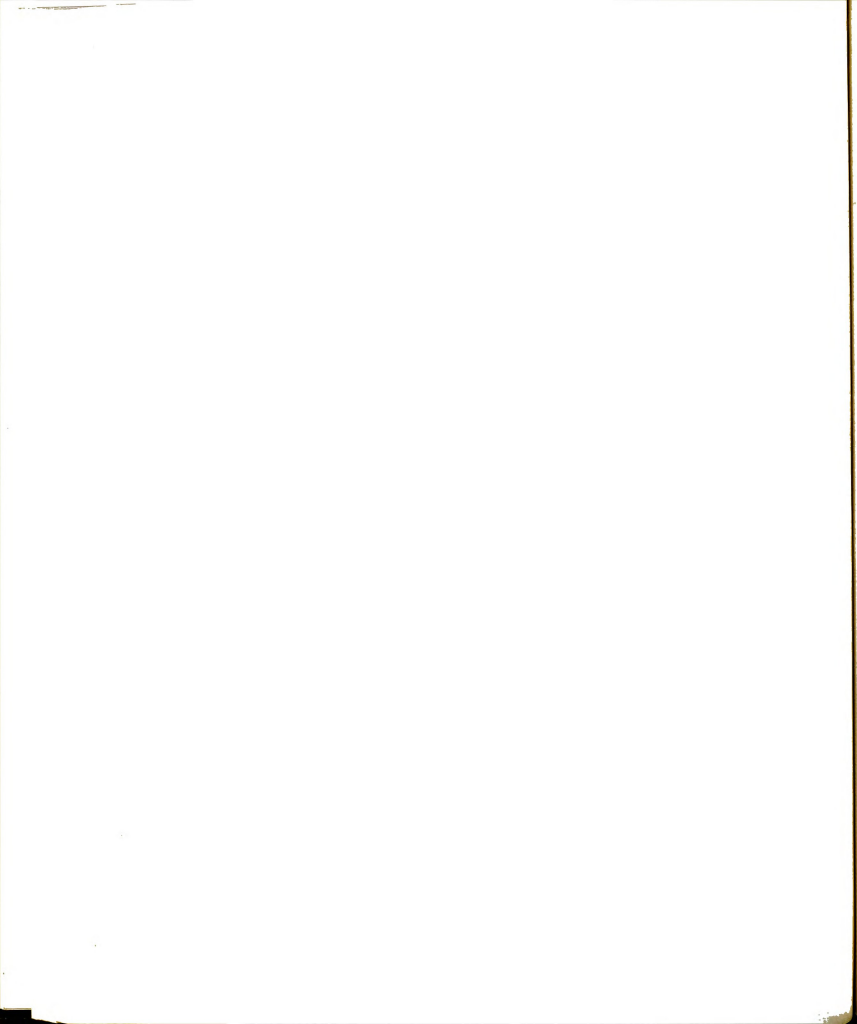


TABLE 5.2.--Summary of Final Evaluation Scores of Migrant Trainees Completing
The Basic Tractor Operators' Course, Grade I (June 1970).*

Trainee Name	Safety Event	Driving Event	PTO Event	Plowing Event	Maintenance Daily Weekly	Written Event	Neg. Score	Pos. Score	Rank
A	50	90	<u>94</u>	70	<u>10</u>	90	8	-412	3084
B	10	<u>71</u>	96	78	90	110	112	-567	2933
C	100	75	104	50	150	<u>20</u>	128	-627	2873
D	250	85	102	156	90	160	128	-971	2529
E	210	171	112	200	90	70	152	-1005	2495
F	100	231	120	182	40	80	264	-1017	2483
G	<u>0</u>	<u>308</u>	191	<u>40</u>	30	100	<u>400</u>	-1069	2431
H	360	82	101	75	130	130	216	-1094	2406
I	170	105	<u>233</u>	109	80	140	320	-1157	2343
J	210	164	147	147	<u>270</u>	110	152	-1200	2300
K	<u>470</u>	129	100	108	160	<u>175</u>	192	-1334	2165
L	300	263	216	<u>232</u>	140	50	232	-1438	2067

* The maximum possible score for the seven events was 3500 points. The trainees were graded on performance tests and assessed penalty points for each error, omission or sub-standard performance. The total raw score of negative points was then deducted from the maximum score. The pass/fail point was set at 2300 points for this evaluation. Progress during training and the instructor's daily evaluation and rating on attitudes, skills and knowledge were also considered in arriving at the cut-off point for certification as a qualified Basic Tractor Operator, Grade I.

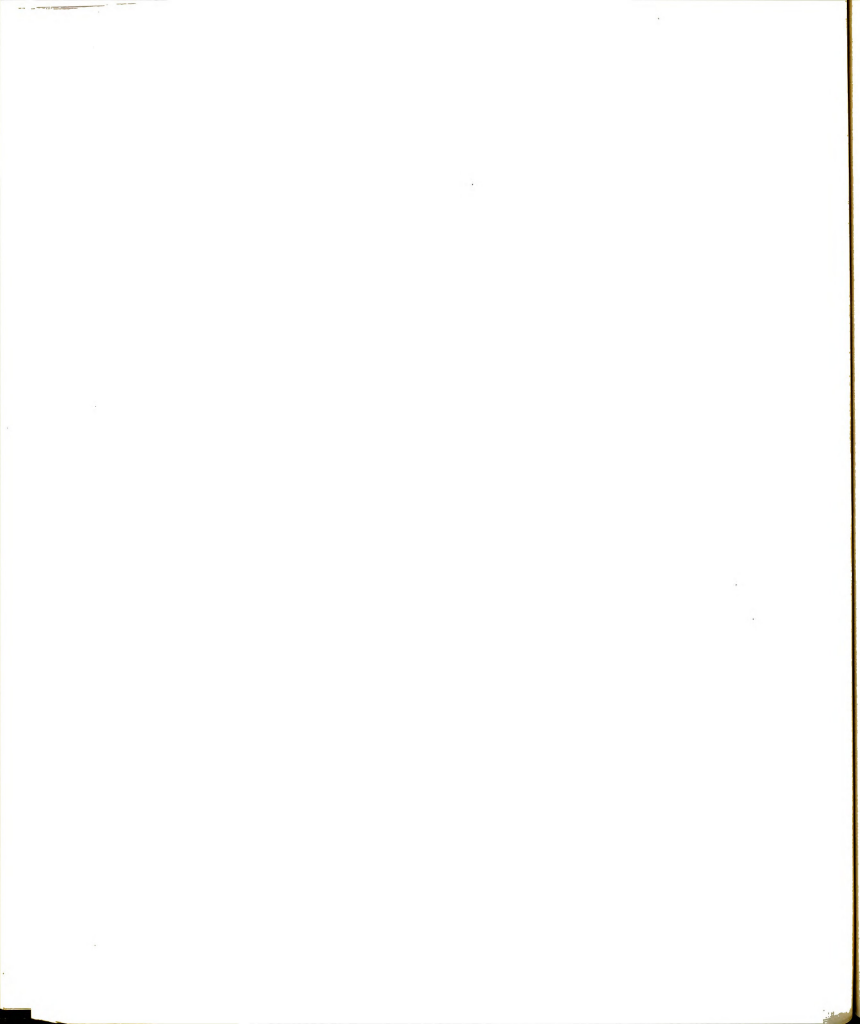


The best scores were received by the upper 50 per cent of the class and the poorest scores by the lower 50 per cent, with one exception. The trainee ranked seventh overall received the best score on both the safety and plowing events but the lowest score on both the skilled driving and oral/written knowledge events.

Since the score on the performance tests depended on how many event items each trainee missed and on their weighted value, the scores varied considerably. The negative scores ranged from a minimum of 0 to a maximum of 470, with only one score for any event exceeding 400. This was also necessary to compute the item analysis and analyze the tests on the computer using the scoring scanner which had a maximum capacity of 400 points.

The trainee receiving the high score was disqualified because of heavy penalties for safety violations. Since safety was stressed throughout the course, the safety judges were critical of any unnecessary risks or hazards. This trainee was penalized for skidding his wheels in starting and for not giving way to a spectator. Except for this he would have scored considerably better and been qualified. This was the one score exceeding 400 points.

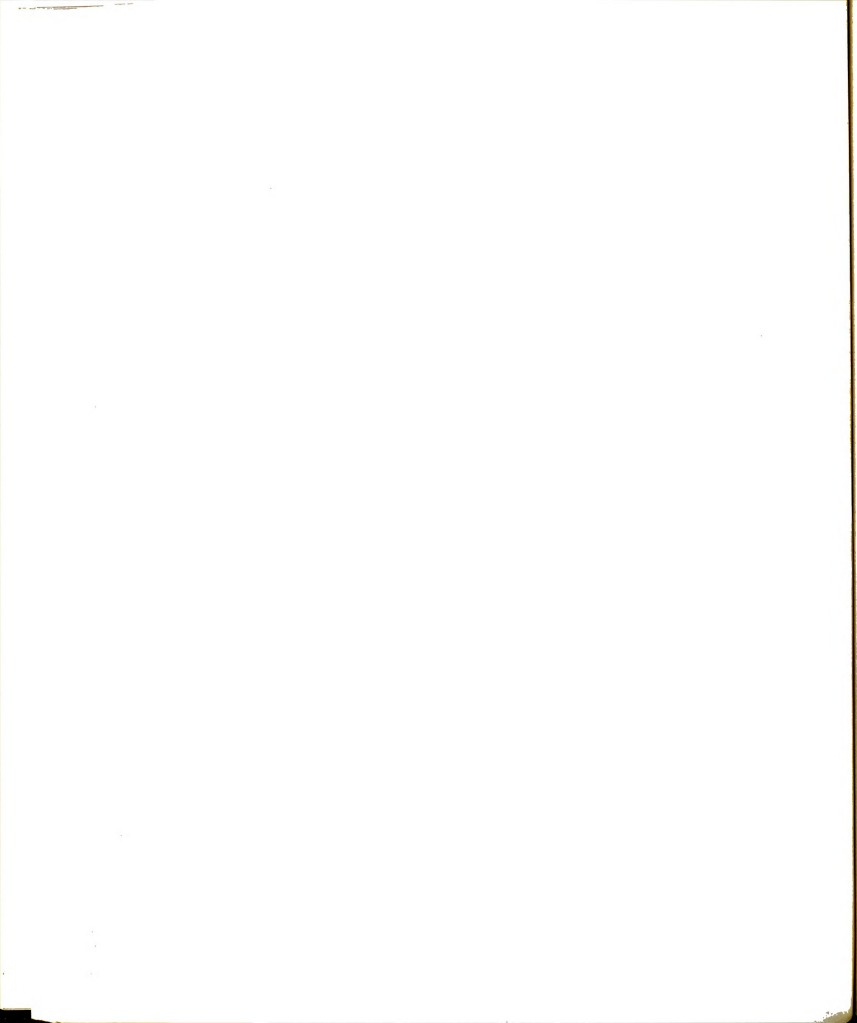
Most of the difficulty in the skill driving course occurred while the trainee was trying to back the two-wheel trailer down a long narrow lane only two feet wider than



the vehicle. For each stake marking the lane that was dislodged or knocked down, the trainee lost 100 points. Perhaps this penalty was too severe.

The trainee who made the lowest grade on the oral/written knowledge test would have done much better but he failed to turn in his answer sheet for the first 87 test questions. Consequently he was heavily penalized, losing about 180 points based on the same percentage he got right on the last half of this event. This would have advanced him to fourth place in rankings.

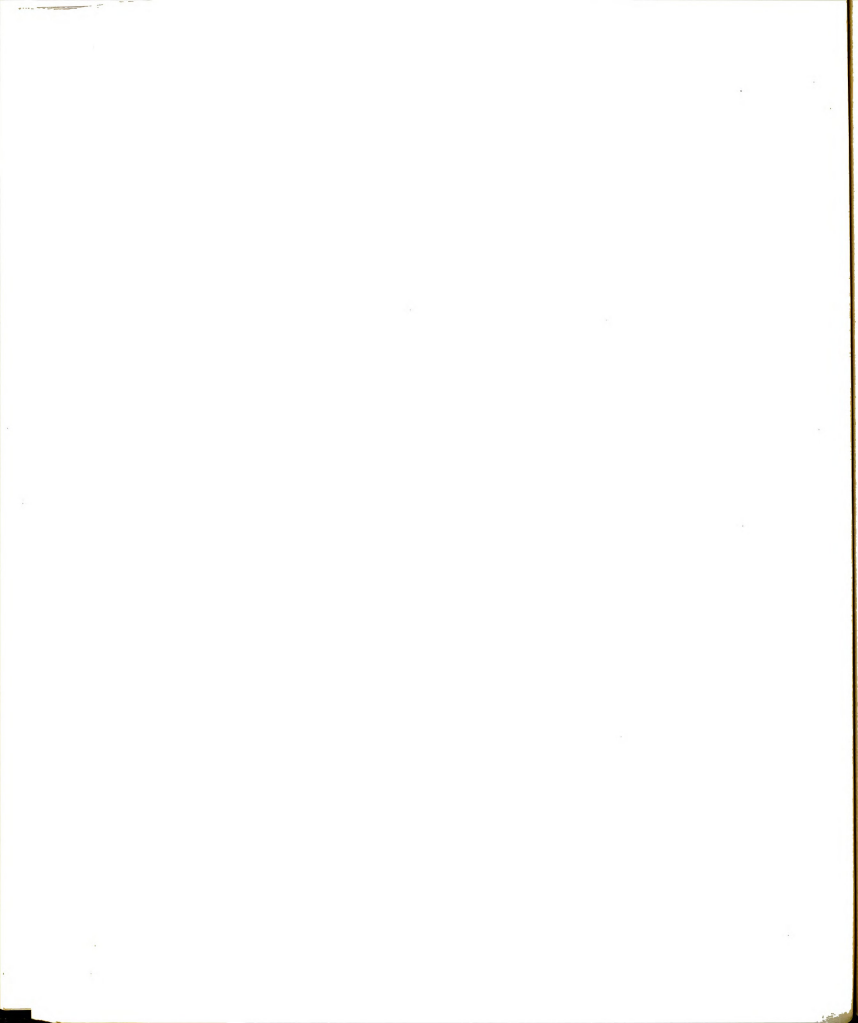
The final evaluation events were an excellent learning experience. Most of the trainees performed better than they had at any practice session. Since they were observed and evaluated by strangers who knew them only as numbers, they were serious and did their best. A practice run under the same conditions used for the final evaluation helped build confidence and relieve worry. Some of the trainees repeated the skilled driving event later on the second day for prospective employers. The judges of this event remarked it was surprising how much they improved once they were familiar with the procedure and the pressure was reduced. Some trainees reduced their penalty points by half or more on this event. This was one reason the driving event was reweighted to make it more equitable with the value of the other events.



The trainees performed very well in these events considering the detailed inquiry made in testing the course behavioral objectives. Evaluators commented on the progress these trainees had made in such a short time. Although the training got off to a slow start with about half of the first two weeks wasted due to poor attendance, the entire course was finished in seven and one-half weeks (half-time). The final evaluation was given the last two days of the course, and was equivalent to three weeks of full-time training on the tractor with three basic field implements--the plow, disk harrow and mower--plus an additional half week on orchard sprayers and equipment used in fruit farming.

An appropriate graduation ceremony was held for the trainees by the sponsor of the course, the Grand Rapids Junior College. Certificates of completion were presented to each of the 10 trainees certified as qualified Basic Tractor Operators, Grade I. The two trainees who did not qualify were given certificates of attendance.

These trainees are now employed in better jobs and half of them are driving tractors as their major responsibility--four as full-time tractor operators and two as part-time operators. The other six are hoping to become full-time operators in the near future. Based on this follow-up and the trainees' present job performance, the course design and plan for the Modified Structured Learning and

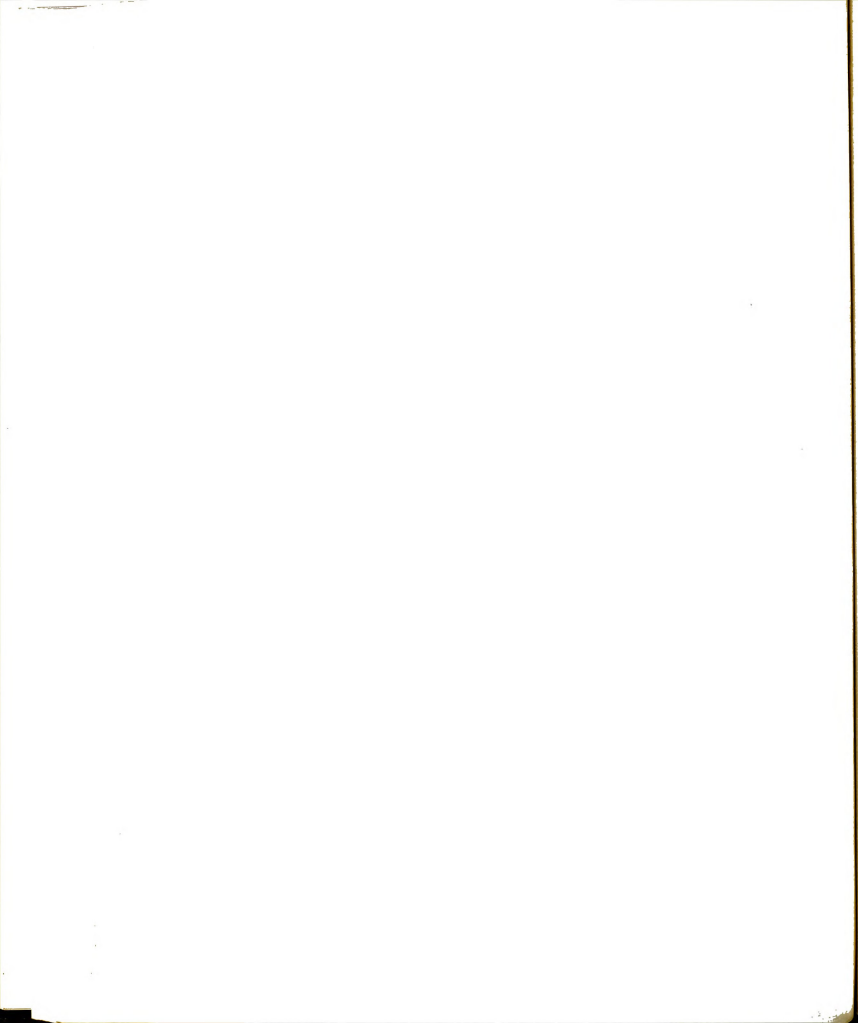


Training Environment, using the systems engineering approach, was successful in training disadvantaged adults as skilled machinery operators.

Summary

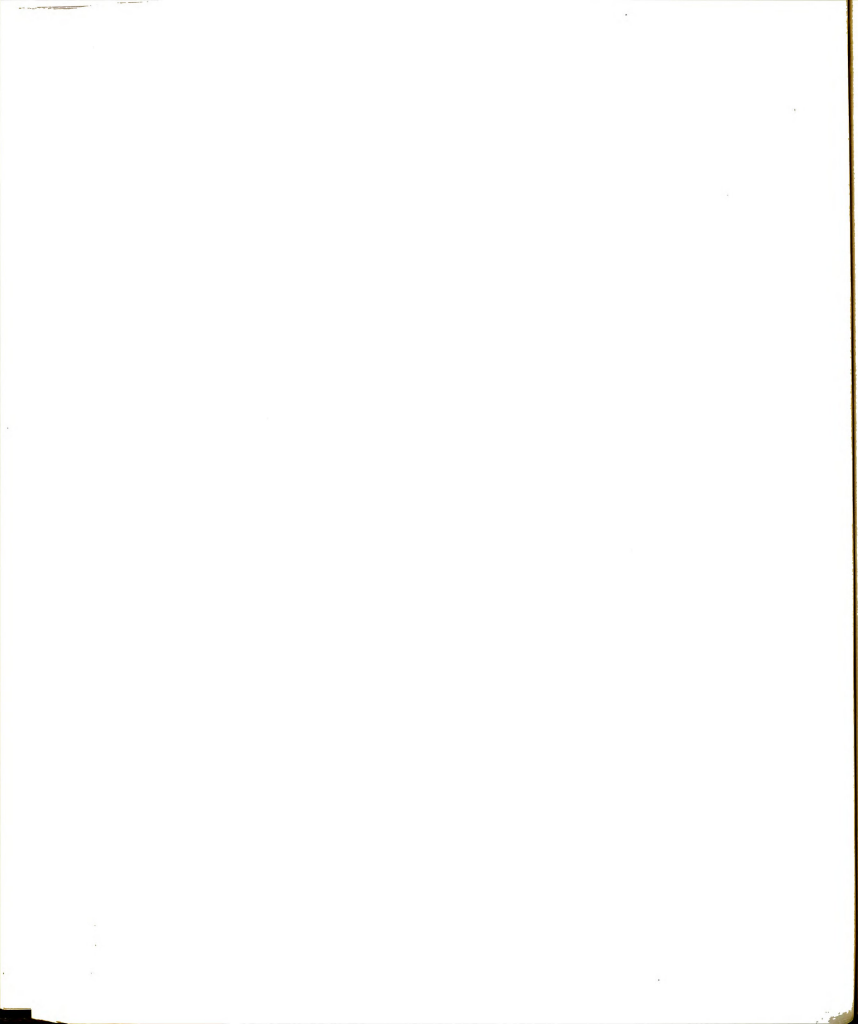
At the request of United Migrants Opportunity, Inc., the Basic Tractor Operators' Course was pretested with Spanish-speaking adult migrant workers. A short workshop was held to train instructors to work with cross cultural trainees. Emphasis was placed on behavioral objectives and trainee evaluation. The attainment of key objectives and individualized instruction were stressed in training. Para-professionals were used as assistant instructors but it was found that more training was needed for effective teaching.

The BTOC was given half-time over an eight week period to a group of 12 to 17 trainees. Hands on and practical training was given in productive farming operations. Lessons learned during the pretest were that potential trainees must be positively identified and interested; all instructors must be more adequately trained; the training program must be well organized and the plan followed; suitable equipment must be available for individualized instruction; facilities must be conducive to learning; the scheduling must be acceptable to trainees; and responsibility for training must be accepted and agreed upon by all cooperating groups.

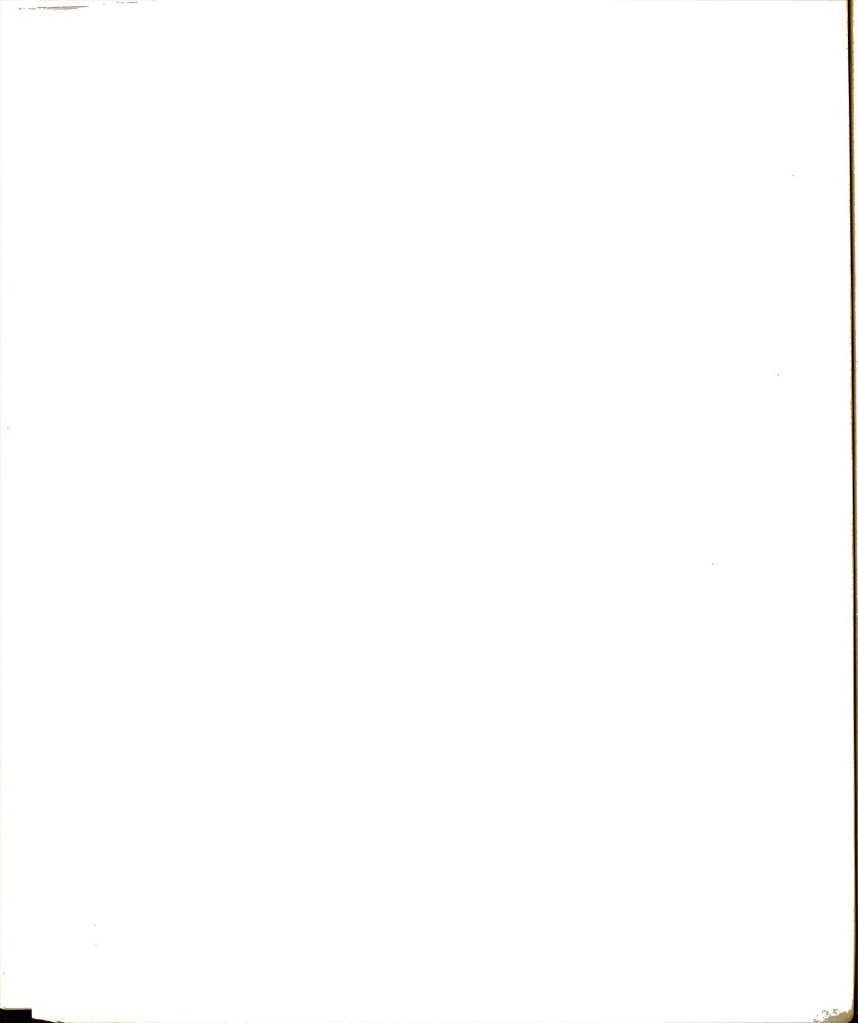


The pre-entry characteristics were given for the 12 trainees completing the BTOC. The validity of the pretests and post-tests were discussed. Based on the difficulty of bilingual communication, the pretests may not measure what the trainee knows as he enters training. Furthermore, the trainees pretraining knowledge and attitudes are apparently not important in selecting or rejecting potential trainees. In the daily evaluation of trainees it was found unnecessary to list individual checkpoints after the instructors became familiar with the training program. The post lesson evaluation of trainees for positive, negative or neutral attitude and the numerical rating of skills and knowledge from 0 to 3 was found effective in assessing trainee progress.

After all lessons in the training program were completed, each trainee was individually tested on the starred (*) items in the checklists of all major lessons. To demonstrate his proficiency the trainee performed all skills without assistance from the instructor or other trainees. The emphasis was on "doing" with special attention to daily and weekly maintenance services, skillful tractor handling, safe operation, adjusting and using the tractor with implements and actual field performance. Attitudes and knowledge were also tested with a written and oral exercise.



A special Final Evaluation Form was scored for each major event. In conducting the skill tests, such as servicing the air cleaner, the flow chart at the end of the lesson was used as a scoring guide, with the critical items marked with an asterisk (*). When the tests were completed, the scores on the final evaluation form were summarized and the trainees ranked and given a qualified or non-qualified rating. The ten successful trainees were awarded certificates of completion in an appropriate ceremony.



CHAPTER VI

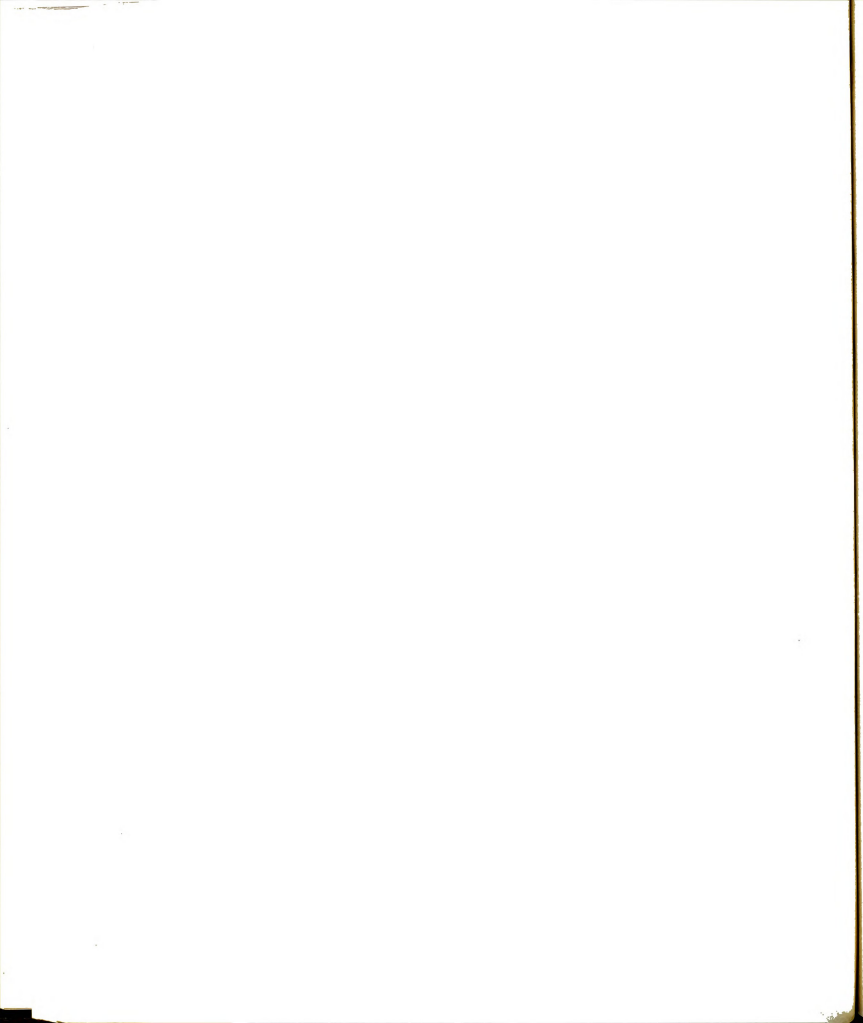
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of Results of Research

The Use of MSLATE and Systems Analysis to Develop Occupational Training

The following sequence was used in developing an occupational training program for basic tractor operators using systems analysis in a modified structured learning and training environment (MSLATE). The training was designed specifically for disadvantaged and low-education level trainees in both developing and developed countries.

1. The tractor operator's job was defined and described in a functional job analysis based on what the worker does and what gets done.
2. The job of the Basic Tractor Operator, Grade I, was broken into tasks and analyzed by flow charts and operations research techniques.
3. Desired behavioral objectives were written for each task element for a minimally qualified operator. The Basic Tractor Operators' Course (BTOC) was written and evaluated on these key criteria.
4. Lesson plans were prepared around the behavioral objectives with suggested instructional techniques and teaching aids.



5. Pretests, daily training evaluations and final performance testing were based upon the behavioral objectives and developed currently with the lesson plan.

6. Trainee activities were developed for individualized instruction and maximum trainee involvement in small group sessions.

7. A suggested schedule and training plan was developed for a three- to four-weeks' intensive course designed to meet the needs of cross-cultural teaching and learning.

8. The basic format for an Instructor's Manual was developed to teach trainers how to use the Basic Tractor Operators' Course and training program.

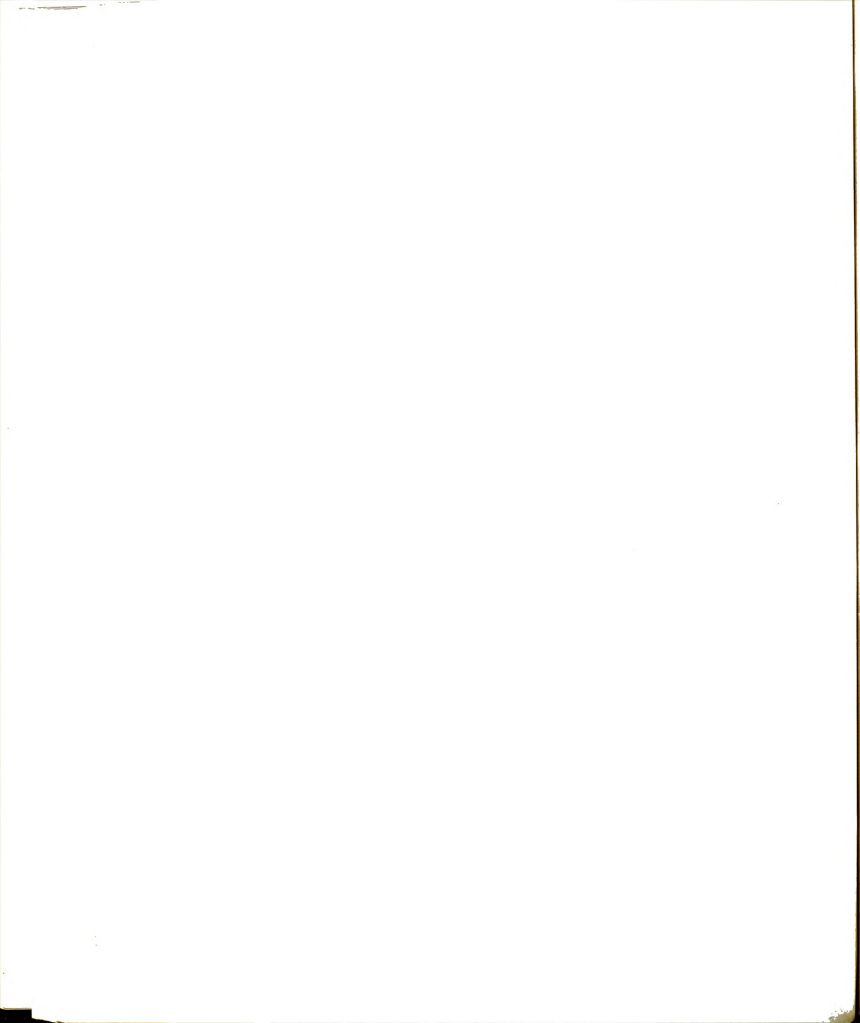
9. Plans were made to conduct preliminary tests of the Basic Tractor Operators' Course overseas in at least two countries.

10. Visual aids and demonstrations were developed for use with the lesson plans of the Basic Tractor Operators' Course.

Pretesting the Basic Tractor Operators' Course
with Spanish-Speaking Migrant Workers

To conduct a preliminary test of the Basic Tractor Operators' Course with Spanish-speaking migrant workers, the following procedure was carried out:

1. Upon request from the United Opportunity for Migrants, Inc., and the Grand Rapids (Michigan) Junior



College, a special program course for training tractor operators for fruit farms was prepared for adult migrant workers seeking permanent skilled jobs in agriculture.

2. Based upon availability and qualifications, instructors for the proposed course were selected for a training program in the Grand Rapids area.

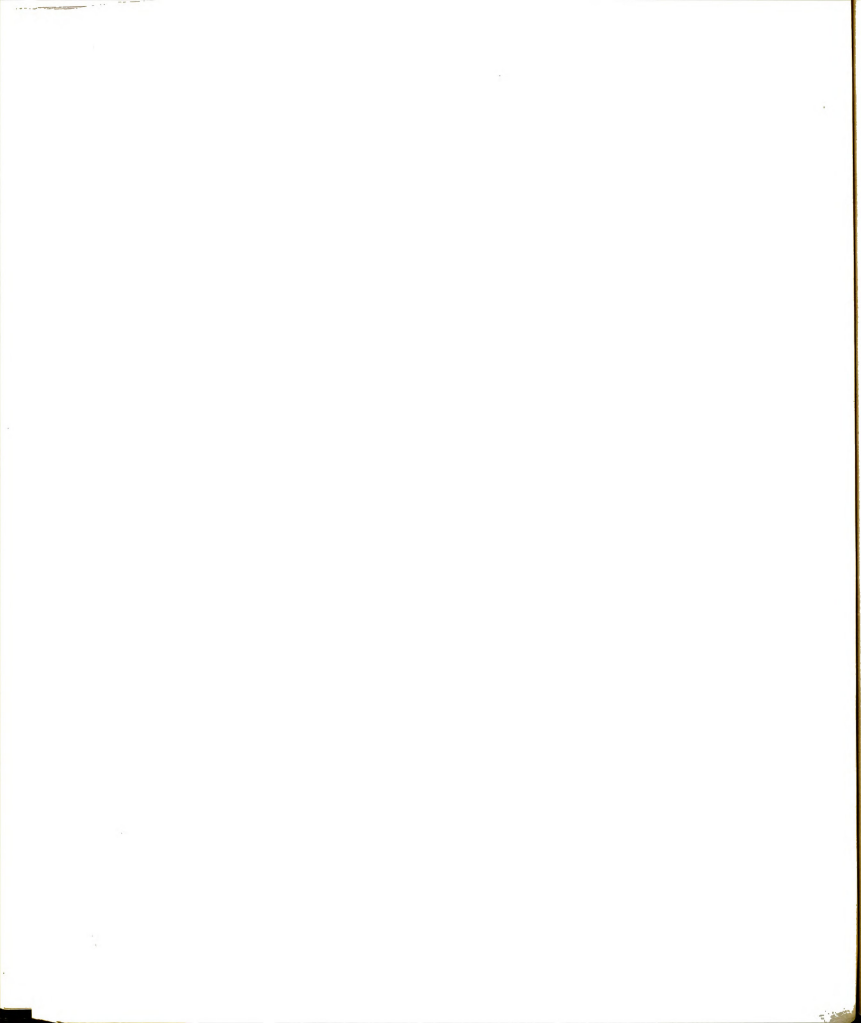
3. Equipment and facilities were arranged through the Rural Manpower Center at Michigan State University and the Michigan Department of Vocational Education.

4. A short familiarity workshop on course design, teaching techniques, and training implementation was held with the head instructor and the four assistants. Behavioral objectives and continuous evaluation of trainees was emphasized.

5. Arrangements were made for one of the two course designers to attend all training sessions, to evaluate the course content and the trainees' progress and to assist the instructors in conducting training.

6. The Basic Tractor Operators' Course with a special orientation class on fruit farming was conducted over an eight-weeks' period in half-day training sessions.

7. The final trainee evaluation was conducted by outside evaluators under actual field conditions. Each trainee was individually tested and scored in seven performance tests representing course objectives.



8. The trainee's performance was judged on pre-established minimum standards on a pass or fail basis, with 83 per cent of those completing the course becoming qualified as Basic Tractor Operators, Grade I.

9. Feedback from the testing program was used to revise and improve the course design and training program.

10. Realizing the need for it, as evidenced by the feedback, a suggested training program was developed to train instructors to more effectively teach and use the Basic Tractor Operators' Course for upgrading the skills of disadvantaged and low-education level trainees.

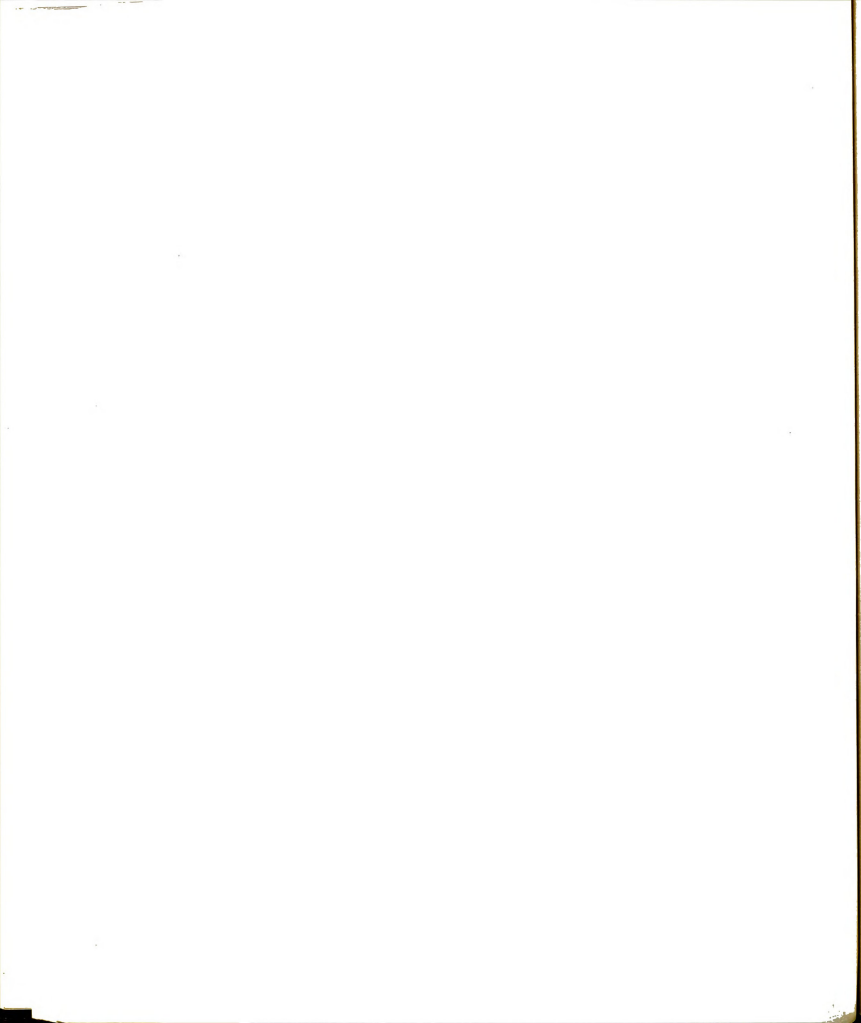
Achievements of the MSLATE Occupational Training Program

Specific achievements of the Modified Structured Learning and Training Environment systems approach to occupational training in agriculture were:

1. The design of a universal training program format for use in training qualified operators for agricultural wheel tractors which can be adapted to the brands and models of various manufacturers.

2. The development of an Instructor's Manual as a guideline to help trainers and instructors do a more effective job of cross-cultural teaching.

3. The production of a detailed program of instruction and core of learning activities which can be selectively taught to trainees of any education level and



background by adding or deleting course materials from a prepared sequence of lessons.

4. The creation of a program of training with built-in evaluation and learning activities based upon clearly defined and measurable behavioral objectives.

5. The formulation of a "hands on" practical type training program for machinery operators especially suited to the needs of trainees with low-education levels and non-mechanical backgrounds such as those found in disadvantaged environments.

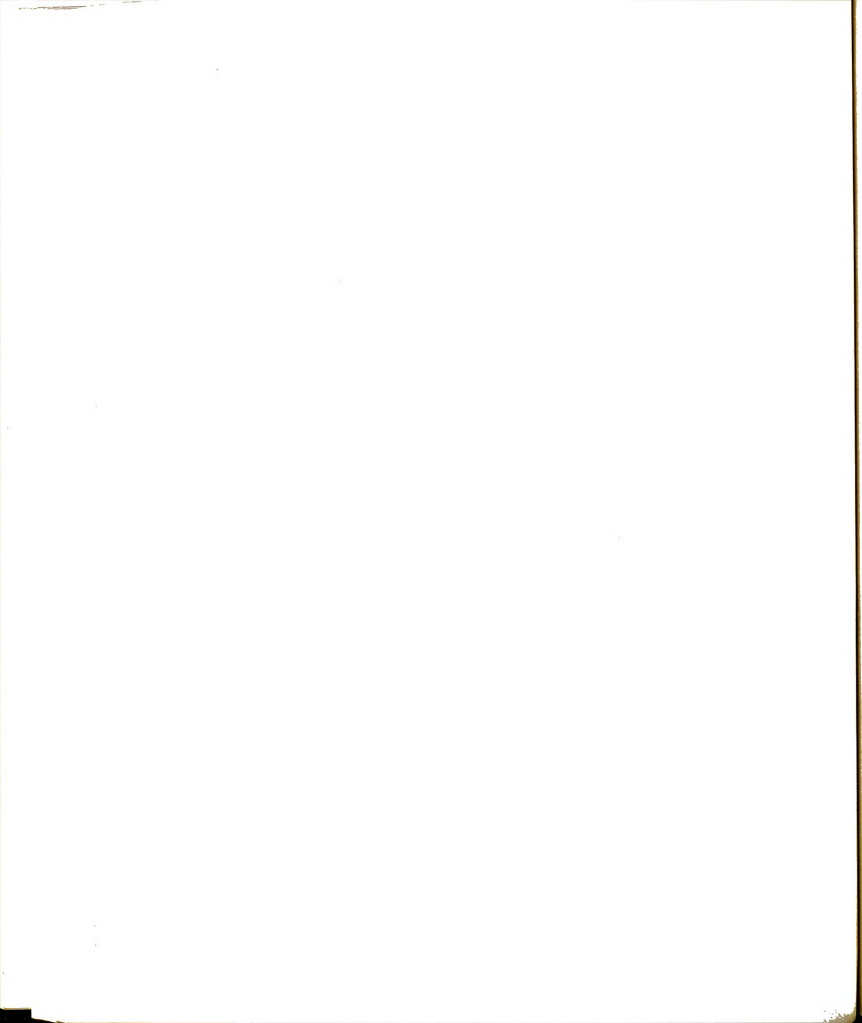
6. The organization of a skilled training program which makes more efficient use of instructors in individualized instruction and multiplies the traditional 1:1 instructor-to-pupil ratio up to 1:5.

7. The development of a general set of useful teaching aids such as colored slides, charts and models which can be produced and purchased at low cost and which can be easily transported for use by training centers and schools.

8. The provision of skill training for a segment of the nation's manpower--the migrant agricultural worker--not served previously by any training program.

Analysis of Hypotheses

1. A different type instructional program is required to adequately train disadvantaged or low-education

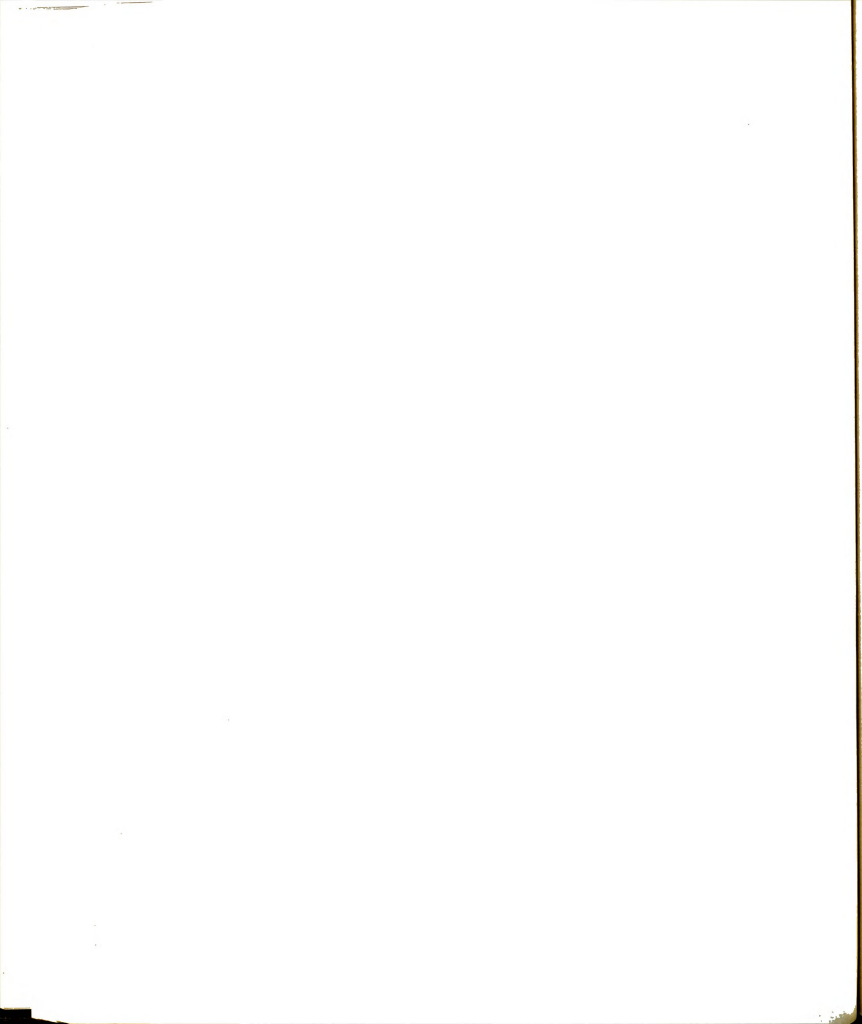


level personnel to operate complex machinery in both developing and developed countries.

To meet the need for an occupational training program structured to impart skills to disadvantaged persons with low-education levels or a record of past failures, the systems approach was used to develop a complete course for a tractor operator. Using the learning concept of SLATE developed by educational psychologists, a modified MSLATE training program was developed for a Basic Tractor Operators' Course (BTOC). The difficulties experienced by manpower training programs and the lack of opportunities for disadvantaged workers to learn an occupational skill, suggested that previous training was either unavailable or inadequate. The BTOC was given to a random group of migrant trainees as a preliminary test of the course. The success of the program in qualifying 10 of the 12 trainees who completed the course showed that such training can be effectively accomplished. The problems and difficulties in communicating cross-culturally and in instilling positive behavioral changes support the acceptance of this hypothesis.

2. A properly structured training program will significantly decrease the time it normally takes to train qualified machinery operators.

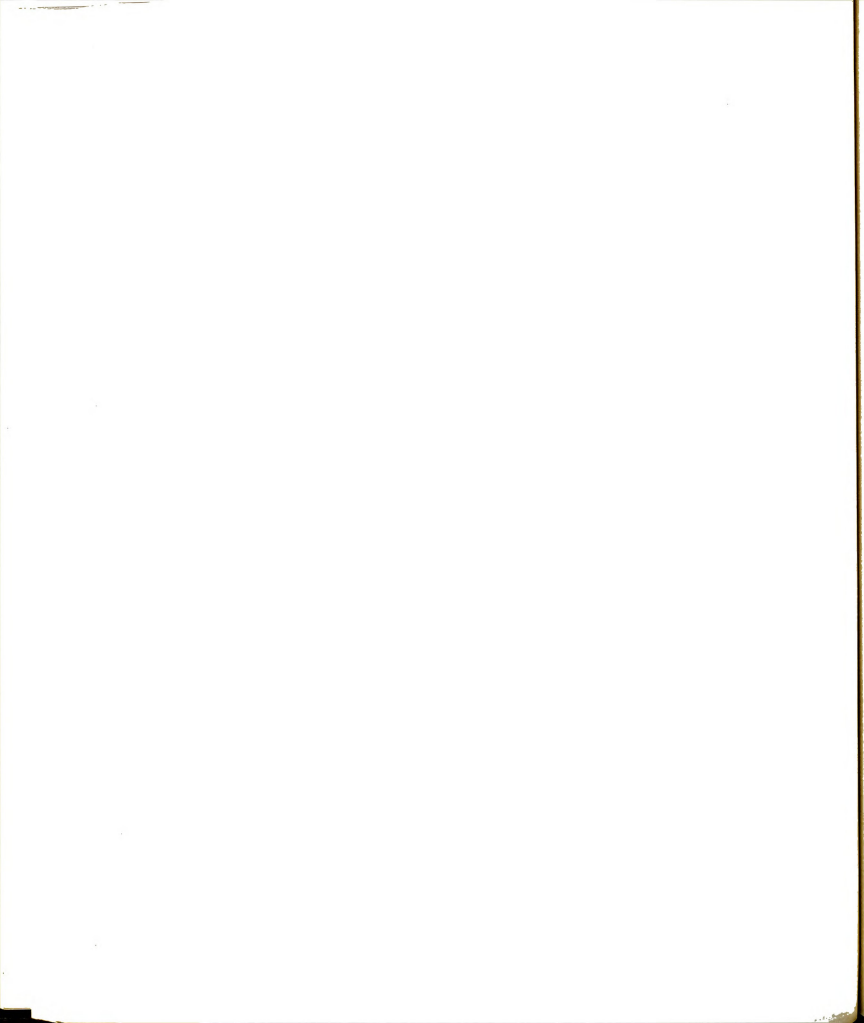
The average training program used to teach occupational skills lasts from six months to two years for machinery operators. One specific training program, the



Narosurra Mechanization Training Scheme in Kenya, attempts to train African farmers and contractors in three months. The goal of the BTOC was to design a structured course that could be taught more efficiently in one-third to one-half that time. As developed and pretested, the BTOC of 65 lessons was programed and taught in less than four weeks' full time. The achievement of qualification by the majority of trainees in this shorter time indicates this hypothesis is accepted.

3. A meaningful final evaluation of illiterate or low-education level tractor operator trainees can be made by using especially designed performance tests and visual observation procedures.

Evaluation processes were incorporated into the BTOC from the beginning pretests to the seven-event final evaluation which covered two days of performance tests. The difficulty of measuring achievements of trainees with low levels of formal education was given special attention in the BTOC program. Performance testing using an absolute pass or fail scoring system was accepted as the only method of ascertaining whether the trainee met qualification standards. To rank trainees, penalty points were assessed for errors or omissions during the individual tests. The few deficiencies assessed trainees during the final evaluation and the general consensus of the outside evaluators that contestants had performed well under



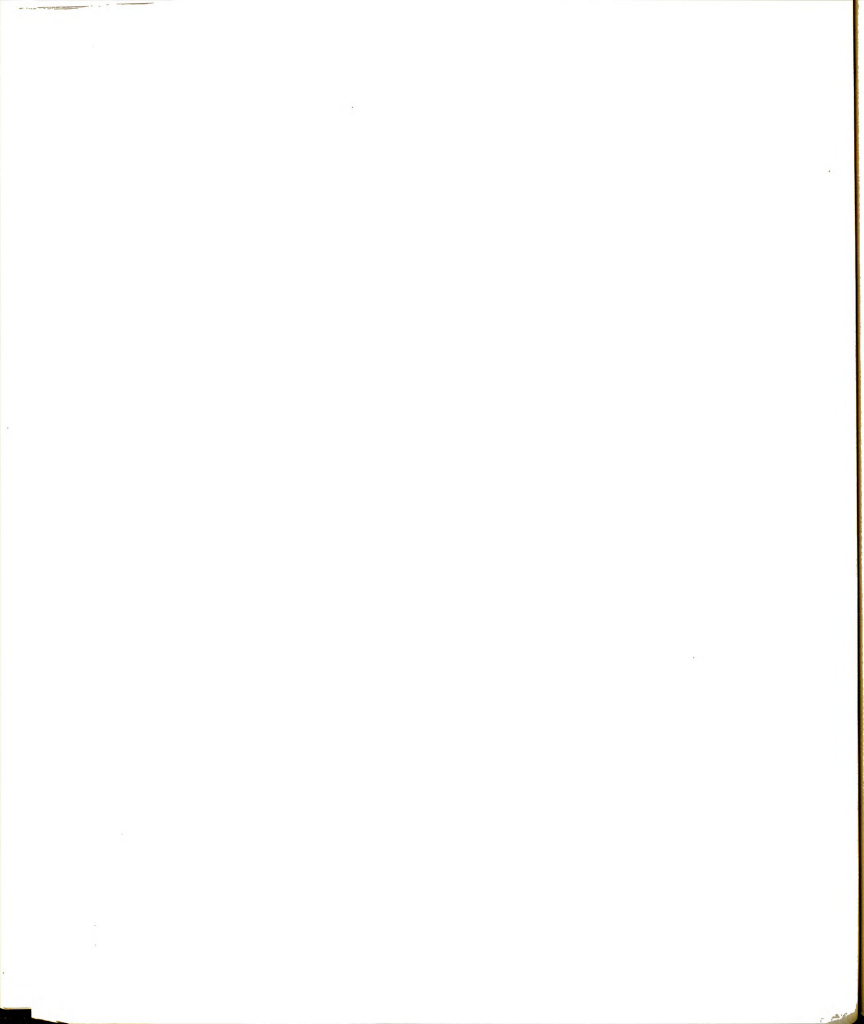
real-life conditions leads to the acceptance of this hypothesis.

4. From a cultural mix, it is possible to select trainees more receptive to training by a series of pretests to identify those who have higher than average aptitudes and states of trainability, irrespective of literacy level.

Because the release of the new non-verbal Special Aptitude Test Battery (SATB) being produced by the U.S. Employment Service was delayed, this hypothesis was not tested. The Michigan Employment Security Service was reluctant to use the regular GATB on trainees with low educational levels when it was hoped the new SATB would be available. Thus no testing was done before training began and no data were collected to accept or reject this hypothesis. This testing is urgently needed to evaluate applicants' potential.

5. With relevant behavioral tests to identify and compare mechanical aptitude and general learning perception, it is possible to predict which trainees, of various cultural backgrounds, are most likely to become good tractor and machinery operators.

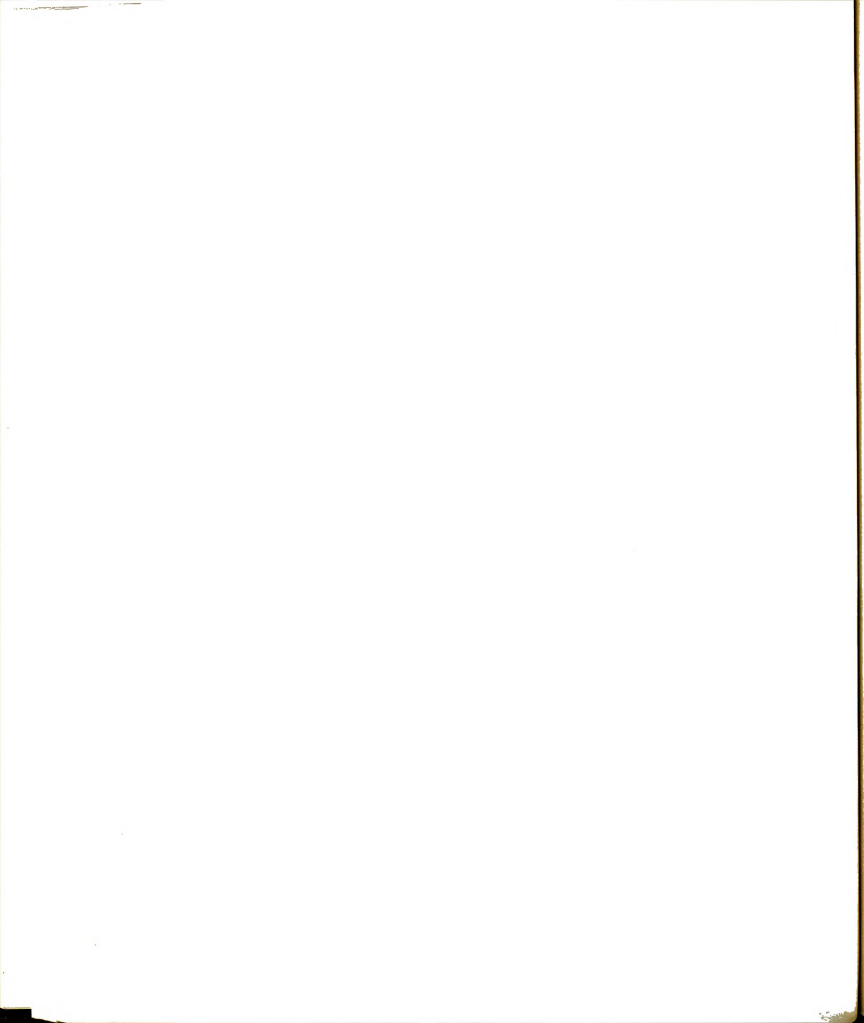
Since the new SATB was not yet available, and since the current behavioral tests were deemed unsuitable for measuring the mechanical aptitude and learning perception of trainees with low educational levels from foreign cultures, these predictions were not made in



this study. The new SATB and the South African Form Series Test should be evaluated in future research to determine their suitability. This hypothesis also can be neither accepted nor rejected since no aptitude pretesting was done with the migrant trainees. Again further research is needed in this particular area.

6. Trainees given a specially designed program of instruction based upon structured learning will learn faster and remember longer than those given the usual lengthy random course or brief and unorganized training.

The fact that the trainees could take 160 hours of training and pass both daily and final evaluations on attitudes, skills, and knowledge indicates that this hypothesis is correct. The individual performance in the final two-day evaluation of applied learning showed that the trainees made acceptable progress in attaining course objectives. Their rate of learning and length of retention was not compared with that of individuals given the usual few days of haphazard training or with that of those taking a much longer and different type of course. While indications point to acceptance, the hypothesis can be neither accepted nor rejected at this time since comparisons do need to be made.



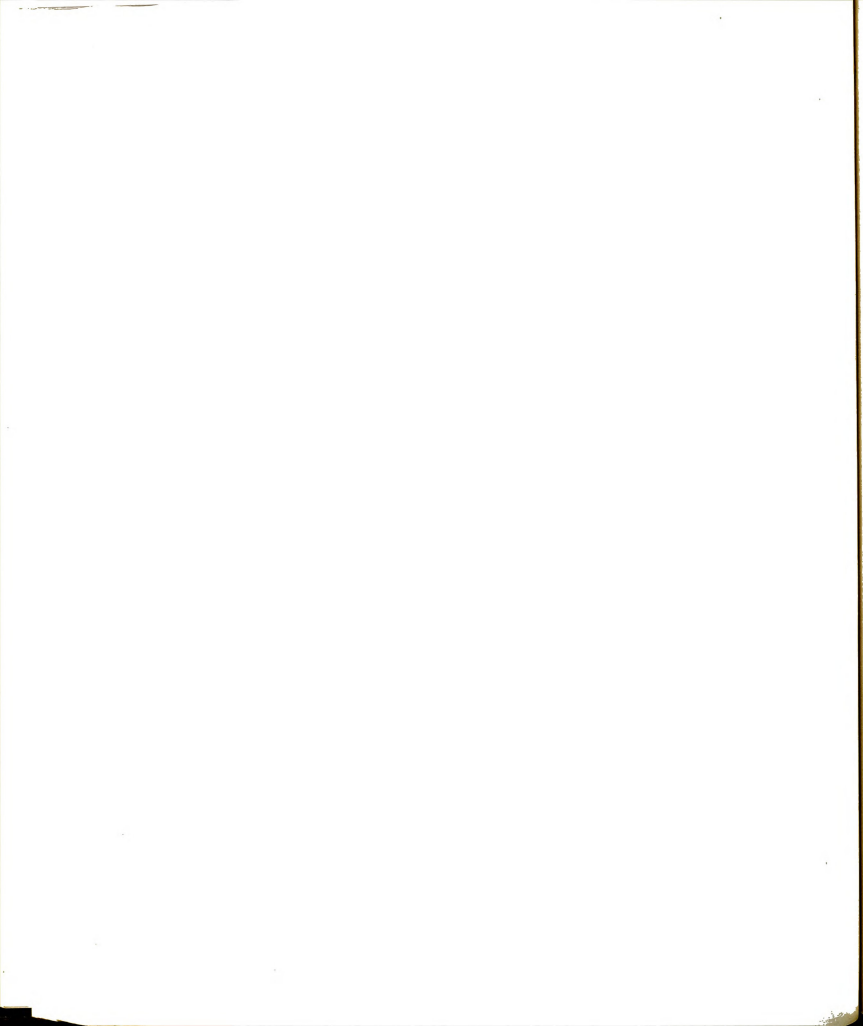
7. The bilingual local leader, adequately trained as an instructor, can more effectively train local people of his own language and background.*

As preliminary testing of the program was not carried out in foreign countries as planned during the summer of 1970, this phase of the validation plan was not conducted. Based upon the limited training given to instructors in the U.S. pretest program with migrant workers and upon the need for additional instructor training, it was clear that more adequate instructor training is needed everywhere. The hypothesis as stated can be neither accepted nor rejected based upon lack of overseas evaluation of instructors.

8. By providing an instructor with a detailed training program and a definite period of in-service training to learn how to use it, a superior type of uniform instruction will be presented to trainees.

The short time allowed to finish developing the BTOC before pretesting it, the unavailability of the selected instructor to take more than two days of in-service training, and the late appointment of assistant instructors did not permit the offering of an adequate instructor training program. The teaching quality of instructors was below expectations because they lacked sufficient

*These hypotheses were not tested because the overseas testing portion of the validation program for the Basic Tractor Operators' Course was cancelled. They are not germane to this study at this point in its development but are suggested as possible projects for future research.

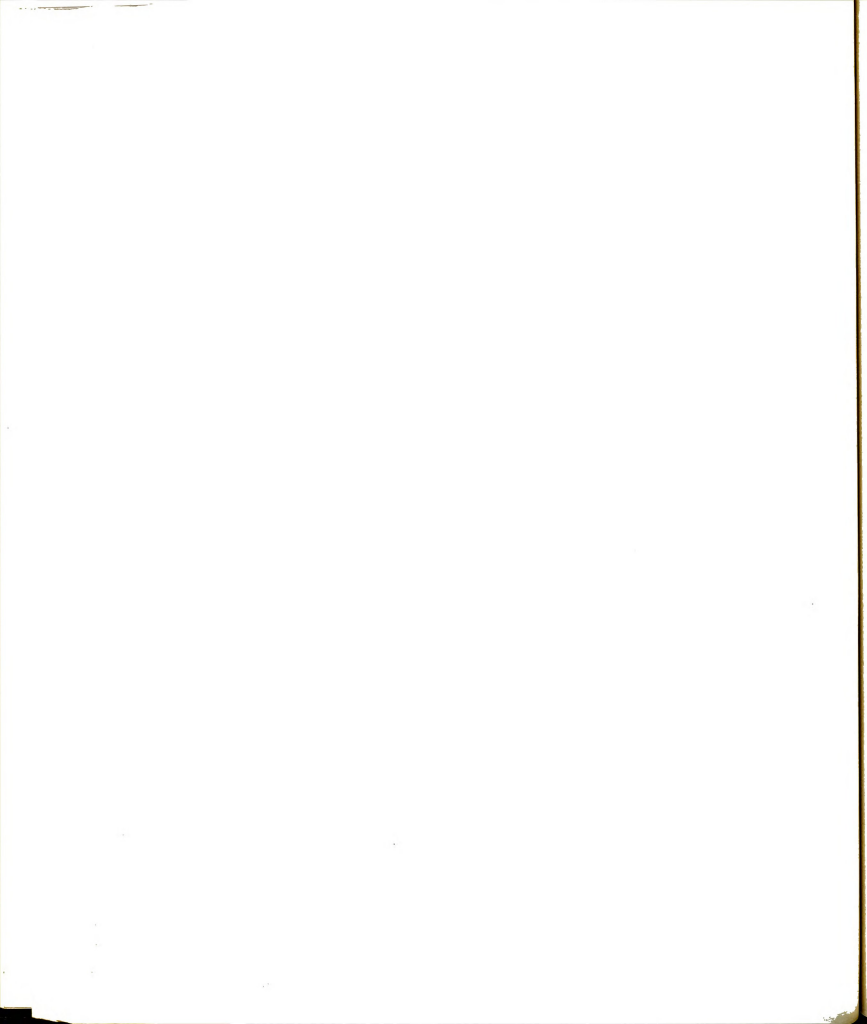


preparation. Detailed training programs and visual aids do not guarantee superior teaching. A structured training program, however, will provide uniform training if it is followed. The hypothesis as stated cannot be evaluated because the in-service training program given to instructors was inadequate. However, as before stated, the feedback from the trial with migrant trainees indicated that instructional training was needed.

9. Uneducated trainees can learn to become good machinery operators capable of exercising basic judgments and decisions by completing a practical course of "hands on" real-life training.

Trainees from disadvantaged backgrounds with low levels of education successfully completed a half-time eight weeks' BOTC. They were given both knowledge and skill training with emphasis on attitude development. Through practical application, they learned to make rational judgments and decisions. The hypothesis is conditionally accepted based upon the results of the preliminary trial program with Spanish-speaking migrant workers from Puerto Rico and Mexico.

10. Tractors and other machinery used and cared for by trained operators will last longer, require fewer repairs, have lower operating costs and have a higher hourly productive output than machinery driven by "drivers" who are untrained or are trained by traditional methods.*

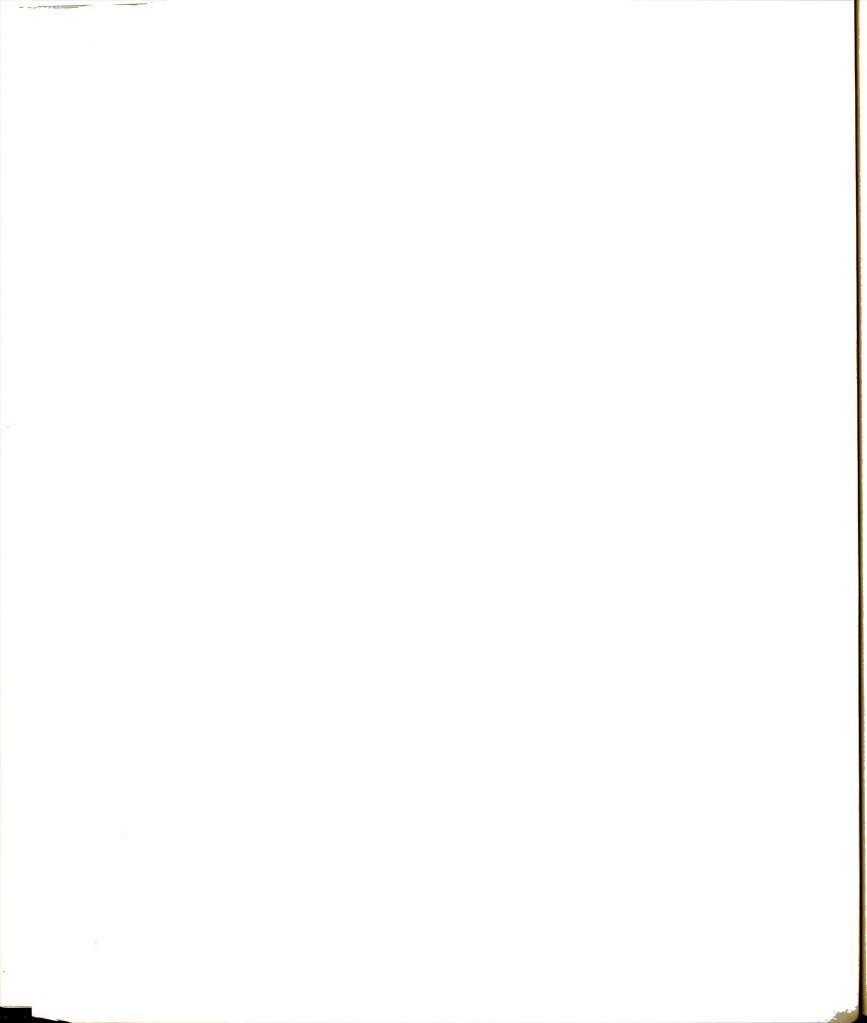


Limited records and analysis indicate this is true, but the hypothesis was not tested during this study. Research is suggested to collect the data needed to compare the effects of good operator training upon machinery life, operating costs, and work output. No data is available from this study to either support or reject this hypothesis.

Conclusions of Study

General conclusions were made about mechanization training based upon the need for training and the subsequent development of an occupational training program for qualifying tractor operators:

1. All farmers and machinery operators require specialized training to safely and properly operate and maintain today's sophisticated farm tractors and implement systems.
2. Without adequate training, tractor and machinery operators cannot be expected to perform daily and weekly preventive maintenance practices which prolong machine life and protect both man and machine from abuse and damage.
3. In the hands of untrained and inexperienced drivers, tractors and their associated equipment do very poor to mediocre work and become economically unprofitable to use.
4. Performance-oriented training programs based upon a pass-fail absolute rating system must be provided



by industry and governments to users and purchasers of new and unfamiliar equipment if it is to be used rationally, efficiently and economically.

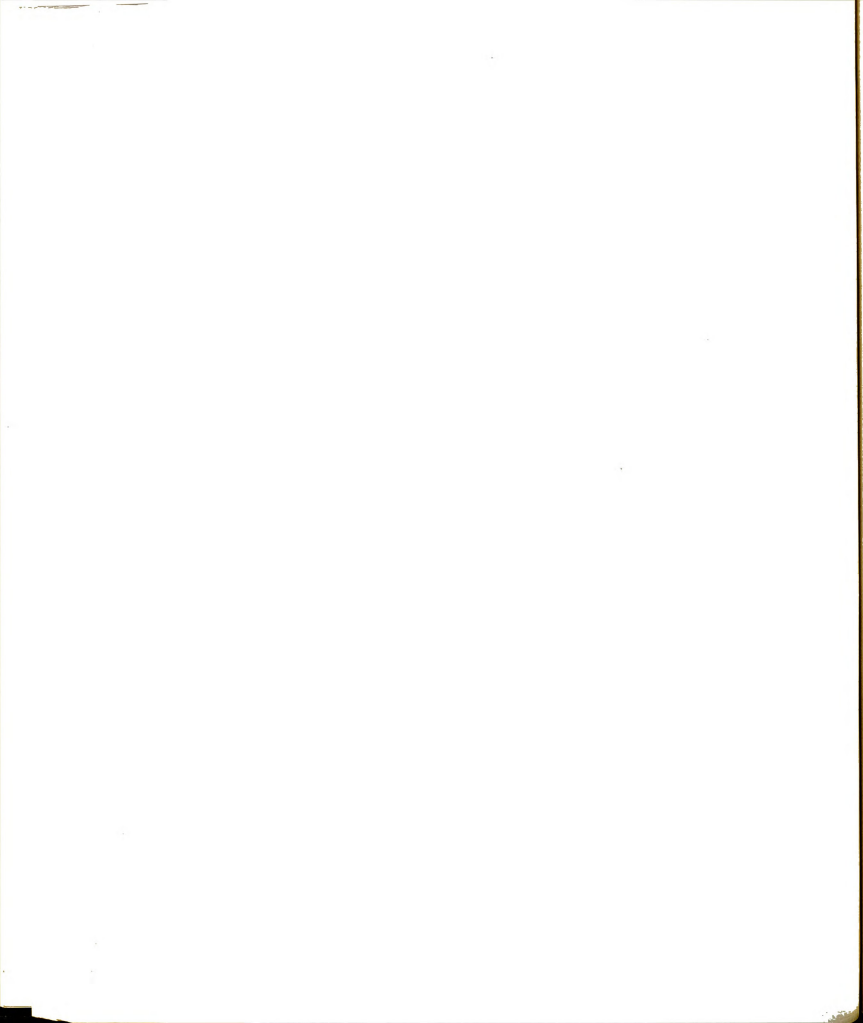
5. The adoption and effective use of modern agricultural machinery and ideas is limited primarily by the inadequate knowledge, experience and judgment of the men who attempt to use it in developing countries. Often the wrong types of equipment are selected for introduction into a country.

6. There is a large unfilled demand to train low-education level trainees to become qualified machinery operators and mechanics in developing nations.

7. Improved training programs are needed at all levels of agricultural and industrial employment, from the lowest machine operator to the top administrator, to upgrade the attitudes, skills and knowledge of employees and to develop capable supervisory and management personnel.

8. A new concept of "mechonomics" needs to be applied to the problems of agricultural mechanization in which special attention is devoted to man, his machines, and their management.

Some specific conclusions were reached about training tractor operators and the development of a basic course of instruction for cross-cultural occupational training as follows:



1. The systems engineering approach to curriculum design offers a unique way to clearly define training objectives, the course content, and the evaluation program needed to develop effective occupational training.

2. The modified structured learning and training environment provides the basis for individualizing instruction and fitting it to trainee needs for upgrading and for efficient use of available resources.

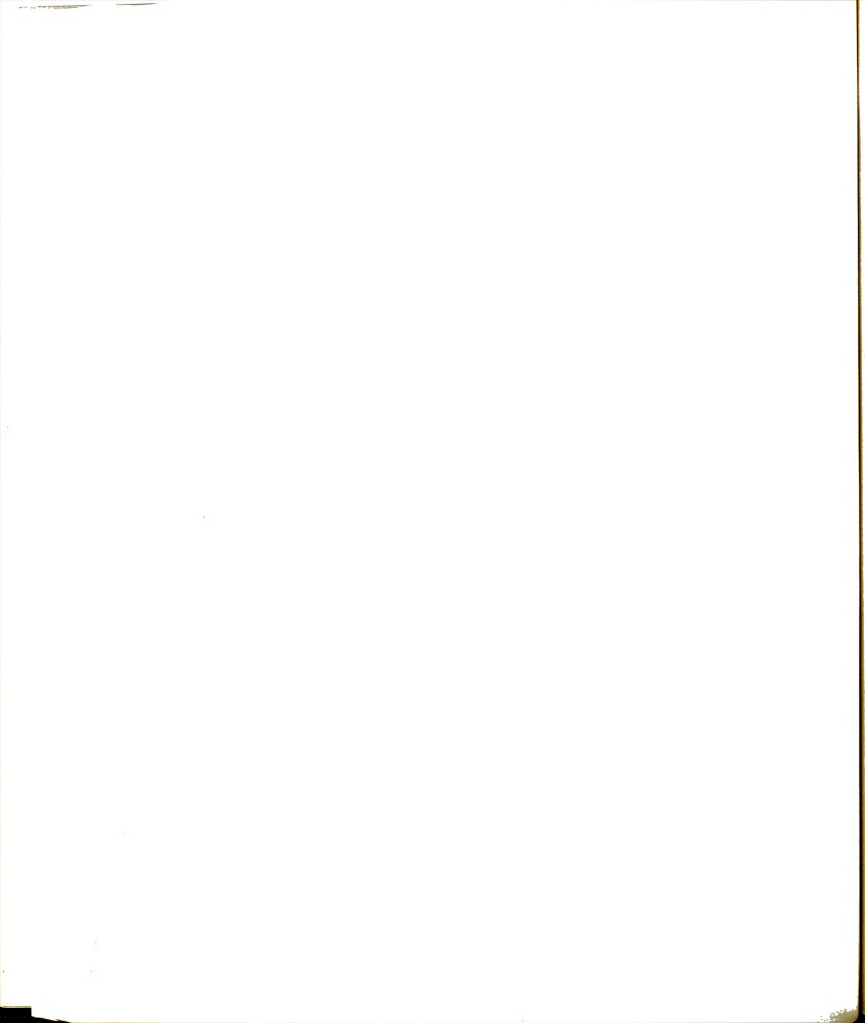
3. The detailed preparation of a structured training program for machinery operators was a sizeable task resulting in a course of 65 lessons for the basic tractor operator of a diesel-powered wheel-tractor.

4. The Basic Tractor Operators' Course (BTOC) along with the training guidelines forms an Instructor's Manual which can be used as a guide in conducting more effective occupational training programs.

5. The effectiveness of a cross-cultural training program to teach trainees with low educational backgrounds depends primarily upon the instructor and his willingness to relate it to their needs.

6. The major short-coming of the present BTOC is its adaptation primarily around one brand and model of a diesel-powered tractor. This was done purposely in developing this first course to serve as a model.

7. The major short-coming of the machinery operator training program for the disadvantaged worker as it was



presented to the migrant group was the lack of adequate pre-instruction training for the instructional staff.

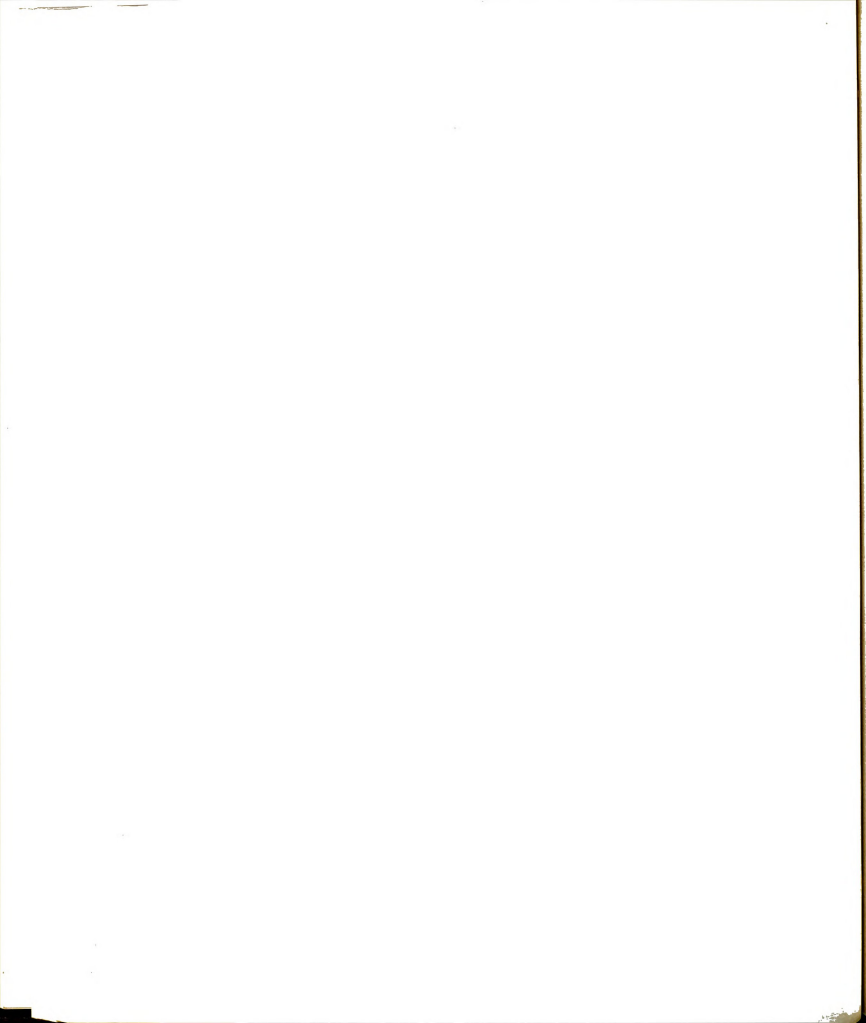
8. Further testing of the BTOC is needed in overseas areas to check its validity under cultural conditions with locally trained bilingual trainers and minimally educated trainees.

9. Future tests should be conducted under controlled experimental conditions to analyze the effectiveness of training and response of pretested selected trainees as compared to randomly chosen trainees.

10. The proposed non-verbal Special Aptitude Test Battery (SATB) being developed by the U.S. Employment Service, or similar tests, should be used experimentally to evaluate the potential capability of trainees and to determine those most likely to become successful tractor or machinery operators.

11. The task of training skilled manpower for tomorrow's needs requires vast resources and increased attention by educators.

12. Most developing countries now face, or soon will face, a crisis in manpower development and training. Only with improved manpower training programs for the masses can the crises be minimized in today's advancing and constantly changing technology.



Potential of the Basic Tractor Operator Training
Program for Manpower Development

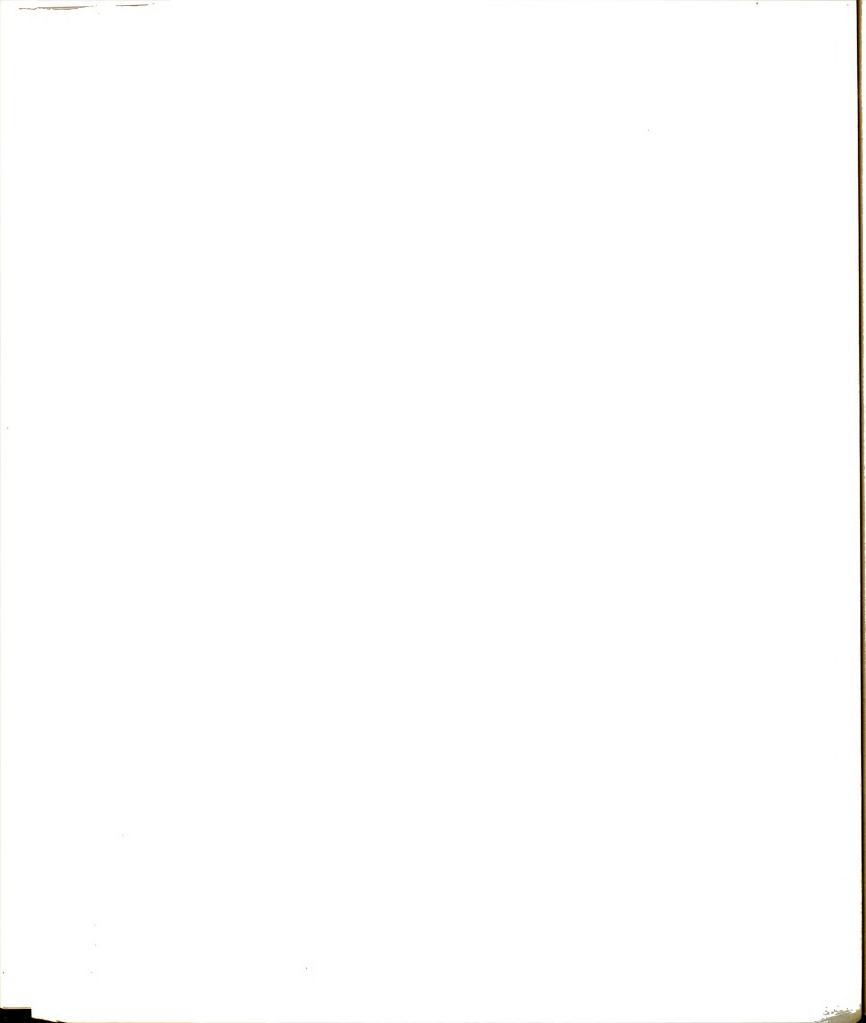
1. The acquisition of basic tractor operator skills by low-education level trainees can provide a new source of manpower skills for the accelerated development of emerging nations.

2. The universal format developed for the Basic Tractor Operators' Course, built around the MSLATE and engineering systems approach, can be used to develop other similar mechanization courses for more effective agricultural and industrial manpower training.

3. The special training material developed for the BTOC, Grade I, can be tailored to specific technological needs and reproduced for world-wide distribution to public and private institutions and agencies in developing countries to improve the effectiveness and reduce the cost of operator training programs.

4. The availability of a proven method of training and a course of structured learning would make it possible for governments to establish new training facilities, wherever needed, with a minimum of expense.

5. An effective, inexpensive course of skilled instruction would permit governments and industry to carry out training locally, to encourage the decentralization of industry and business and to create new job opportunities for thousands of disadvantaged rural people.



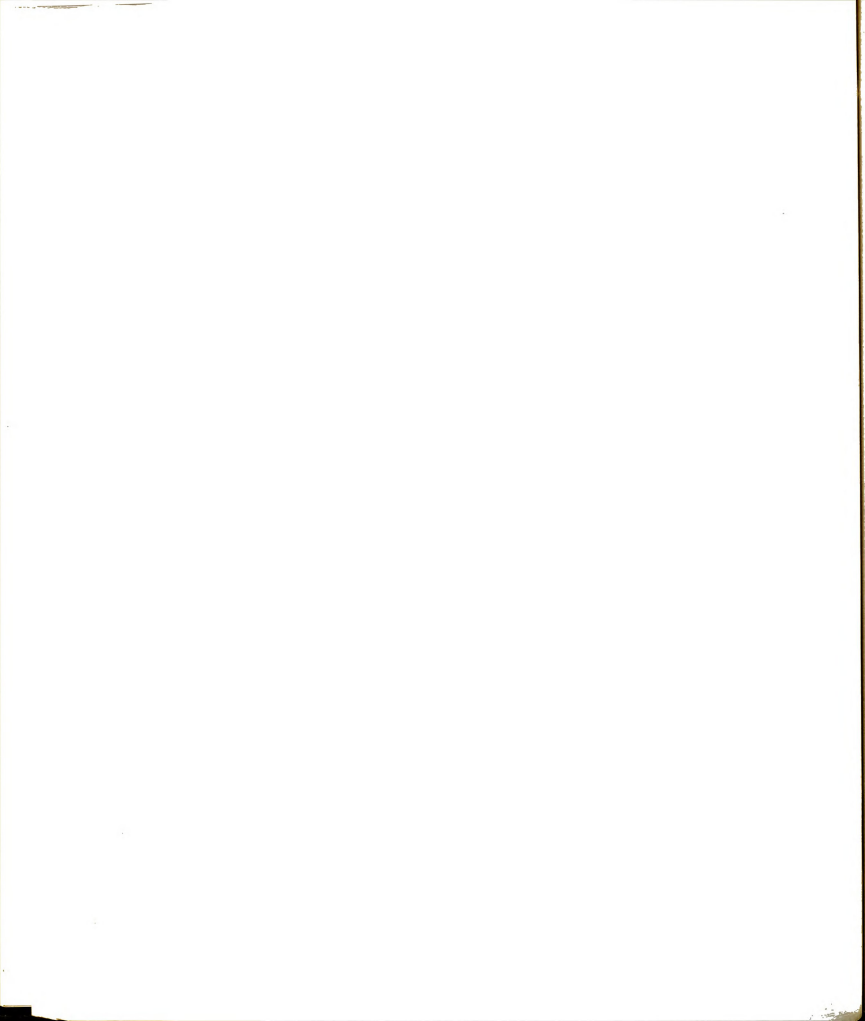
6. Trainees with the basic skills of a wheel-tractor operator can learn additional skills to up-grade their ability levels as machinery operators, factory and construction workers to more fully and effectively employ mechanical power in economical applications.

7. Dealers and manufacturers can assist in the introduction of new technology by providing the latest information and equipment. This will insure availability of the necessary teaching aids and technical data to maintain a high level of training validity.

8. The use of a follow-up program conducted with BTOC graduates could ascertain training strengths and weaknesses. Feedback from this program can provide the basis for constant improvement of the course and for the planning of refresher and up-grading courses.

Possible Uses and Applications of the Study

1. The development of a universal training program for tractor and machinery operators can enable individual farm machinery manufacturers to more easily train their own company and dealer personnel. These key people can then act as master instructors to train local people as qualified tractor and machinery operators. They can also train government workers and vocational staff members from educational institutions who can conduct training for farmers and students enrolled in various training institutes and similar government programs.

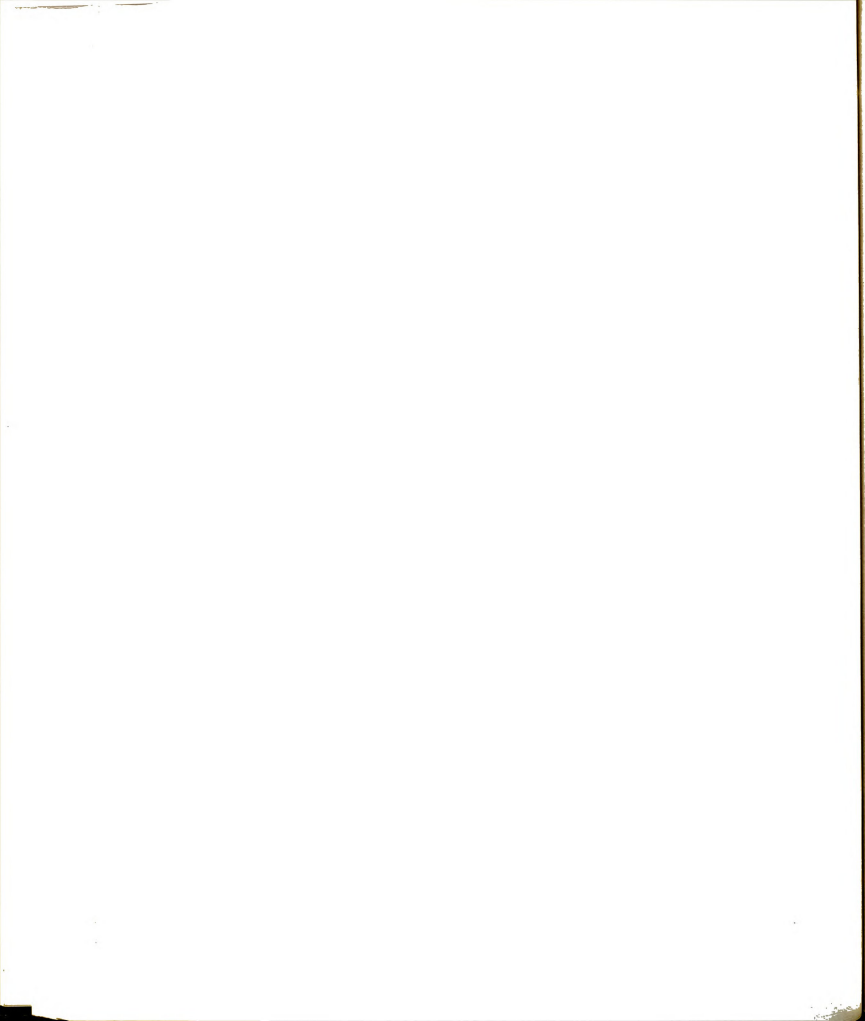


2. The special training materials and instructional programs developed and tested in this study can be made available to individuals and organizations already engaged in training programs for agricultural mechanization. With the Instructor's Manual as a guide, the BTOC can be used to up-grade the caliber of training, to standardize the type of training, to provide for continuous progress, and to increase confidence in the ability of the school and its instructors to do an outstanding job.

3. The development of a training program aimed at minimal education levels can permit governments to tap a vast unused source of manpower and to find employment for young adults and school leavers now unemployable. Such training can be a stepping stone to better jobs and can provide new opportunities for rewarding work for the rural disadvantaged.

4. The design, production, and world-wide dissemination by major farm machinery companies of practical and tested training programs and materials can permit governments to update present obsolete and inadequate training programs to more efficiently meet the needs of developing economies.

5. The development of a universal detailed Instructor's Manual can assist private organizations, plantations, and large commercial agricultural enterprises in improving the caliber of training already being given.



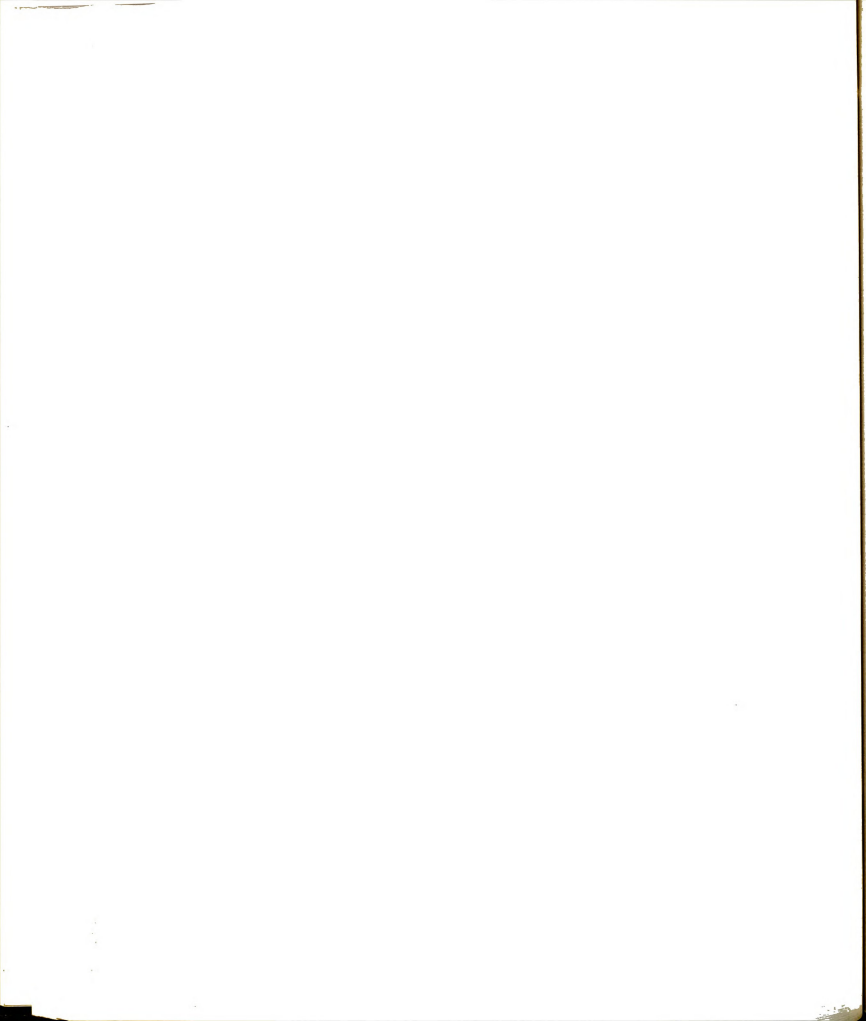
6. The production of a simplified operators' manual, based upon the Basic Tractor Operators' Course, in the primary local language of a nation would permit training institutions and schools to give a useful reference manual to all graduates of tractor operator courses.

Selection of Course Material to
Individualize Instruction

As an example of how the BTOC can be adapted to meet the needs of different skill levels and time requirements, the following procedure is suggested:

The trainees should be selected and pretested to establish entry level knowledge. Based on the facilities and the time available, the instructor can tailor the training program to the trainees' needs by selectively using the prepared lesson materials. The course is divided into eight major sections lettered A through H. Each section is important and should be included in a complete course to train the minimally-qualified basic tractor operator. All of the material presented in sequence forms a three- to four-weeks' course.

Although this course is designed to train a Grade I operator, it can also be used selectively for providing short intensive courses to prepare tractor drivers and for re-training or up-grading current operators. For example, if operators are already proficient in maneuvering the tractor but are weak in care and maintenance procedures, a one-week's

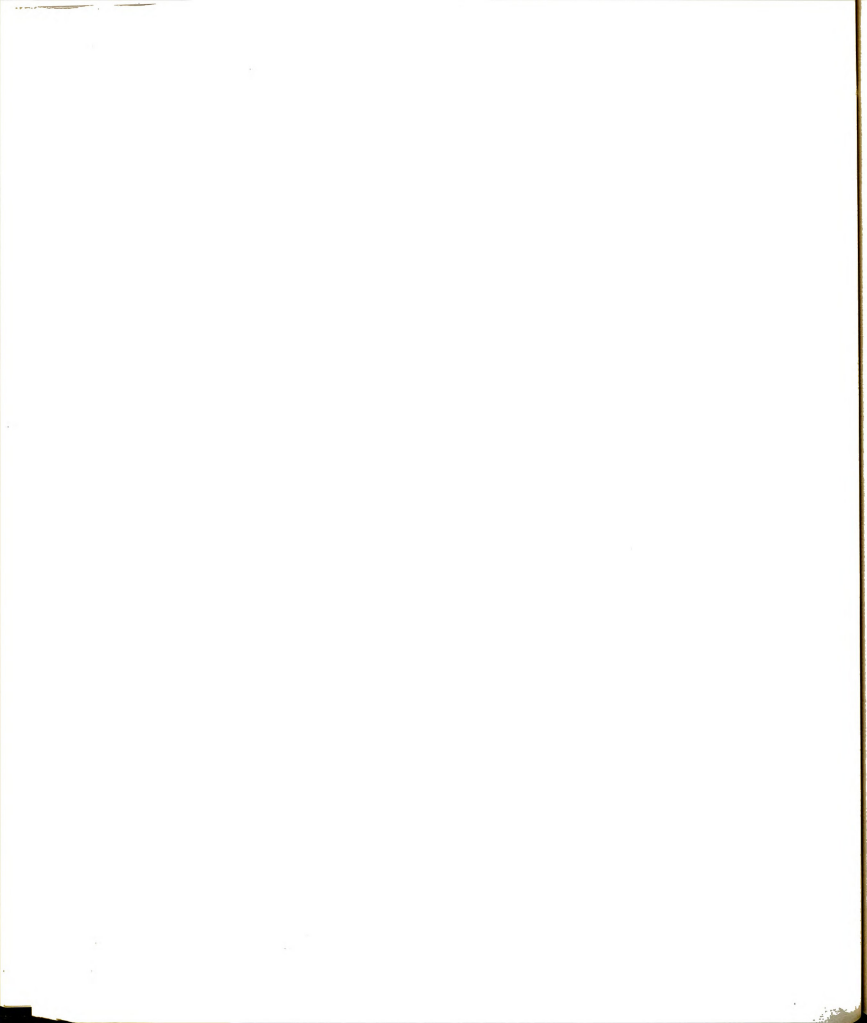


course could be set up using only Section B of the lesson material. The material is very flexible as each section can be used singly. Different combinations of lessons in a section can be used to meet individual needs by choosing only those parts required to bring trainees up to the acceptable standard.

The Concept of Mechonomics--A Rational System of Mechanization

This term is defined as a function of man, his machine, and its management. Of these three elements, man is the critical resource controlling the degree and quality of output from both other sub-systems. Only when man is well trained, has sufficient experience, and can balance the constraints of all systems to optimize their inter-relationships can he achieve success to any degree. The product output or the behavioral change of this mechnomic system is dependent to a variable degree upon many other factors, all of which can retard or accelerate the productivity of these major parts.

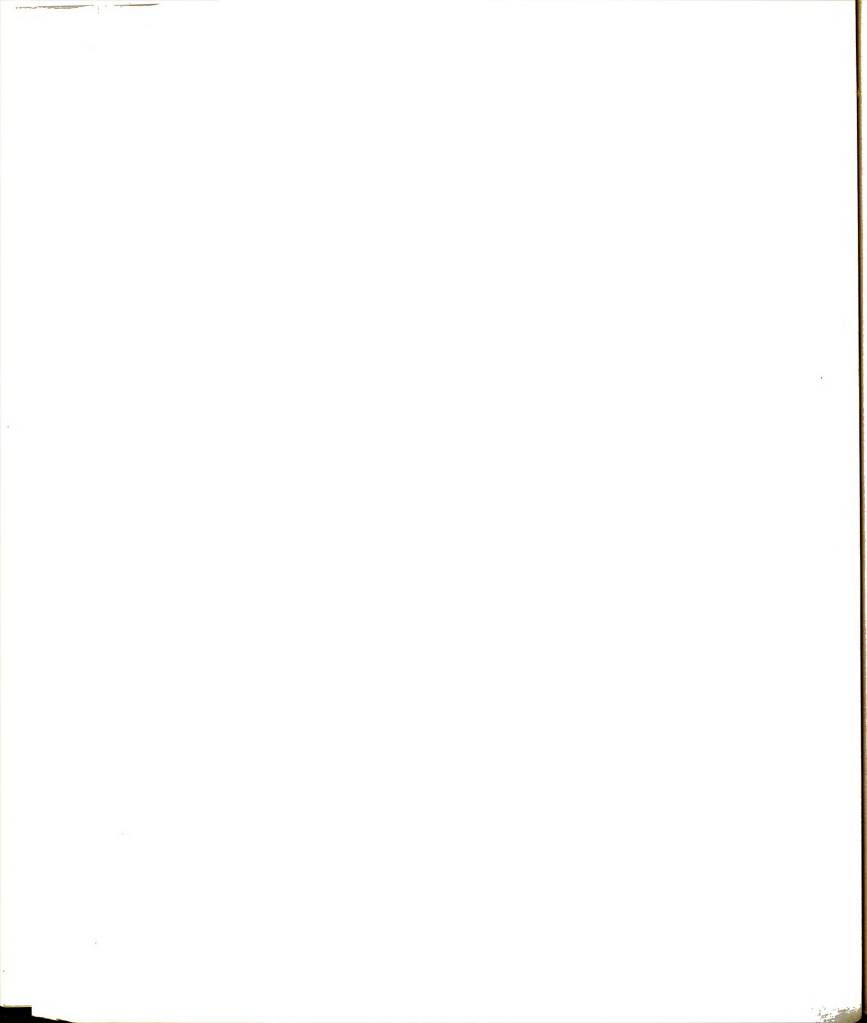
There are many people in various governments of the world who say, "It can't be done" or "It won't work," when they refer to the mechanization of agriculture. Many poorly planned and even less ably implemented attempts have been made to accelerate agricultural development. There have been many striking failures. Some of these could be blamed upon inadequate information, others upon



lack of an acceptable market, some upon the failure to provide adequate supporting services, and still others upon natural calamities and disasters beyond man's control. Very seldom was the machine completely at fault or was there a lack of desire to do better. Nevertheless, behind each of these failures stood short-sighted, poorly trained, or inadequately prepared men. All of these failures could have been prevented by thorough investigation prior to adequate preparation.

Training is critical to the mechnomics concept of man as a director of power. A machine is simply an extension of man's creativity and individual power directed and controlled to perform otherwise impossible tasks. Machines may be programed to carry out routine tasks according to a prepared plan. However, unless a machine is or can be made flexible, it soon becomes obsolete and is discarded. The capacity of man himself to continually size up changing conditions and redirect his plans, machines, and actions makes him superior to any machine so far conceived.

For people who go routinely through life, the big problems are learning how to get along with the machines and systems that other men have created. Since they have not had a part in creating the machine or system thrust upon them, they often have little idea about why it should be used or how. These people must be taught how to manage themselves and their machines. It is not an easy task nor

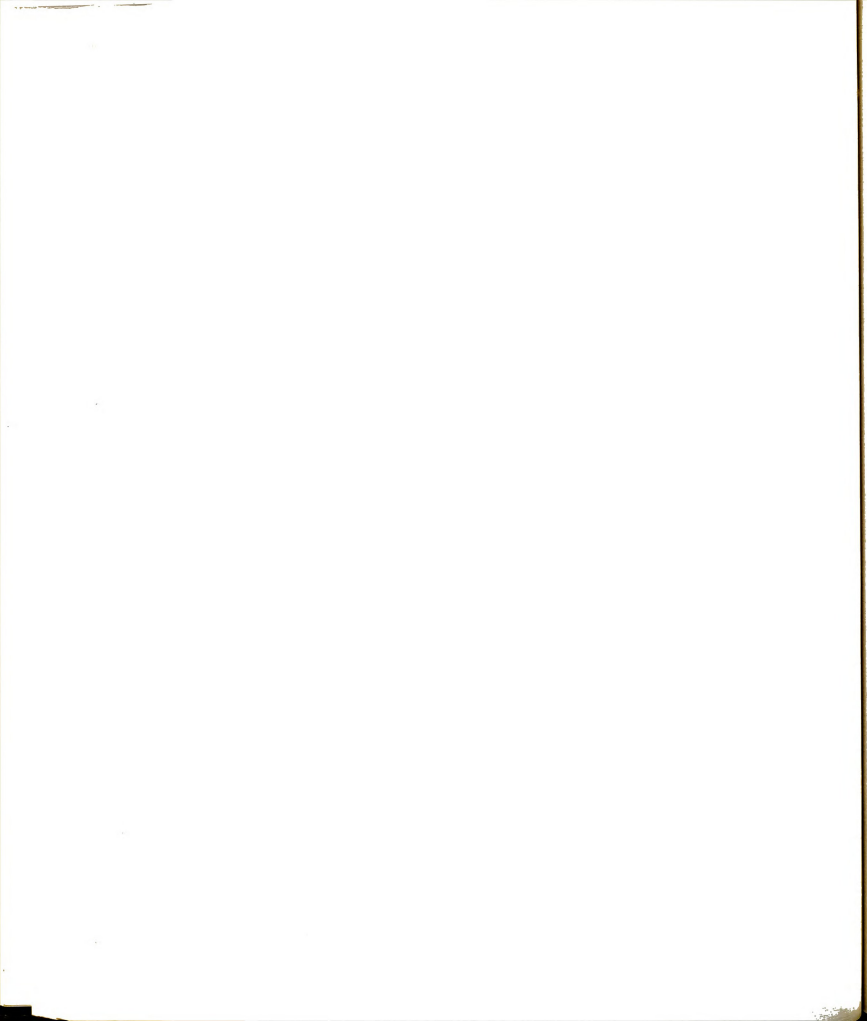


one that can be solved rapidly in our current "society of instants."

Mechonomics implies a clear analysis of the problems, a concrete definition of objectives, the making of a realistic plan, the establishment of priorities of action for each plan element, and the allocation of necessary implementing resources. At each step key people must be used to train additional manpower or to up-grade the training of existing employees to assume greater responsibility. In any organization the aggregate team effort counts, but it can only be summed if each individual does his job thoroughly and uses his machine correctly.

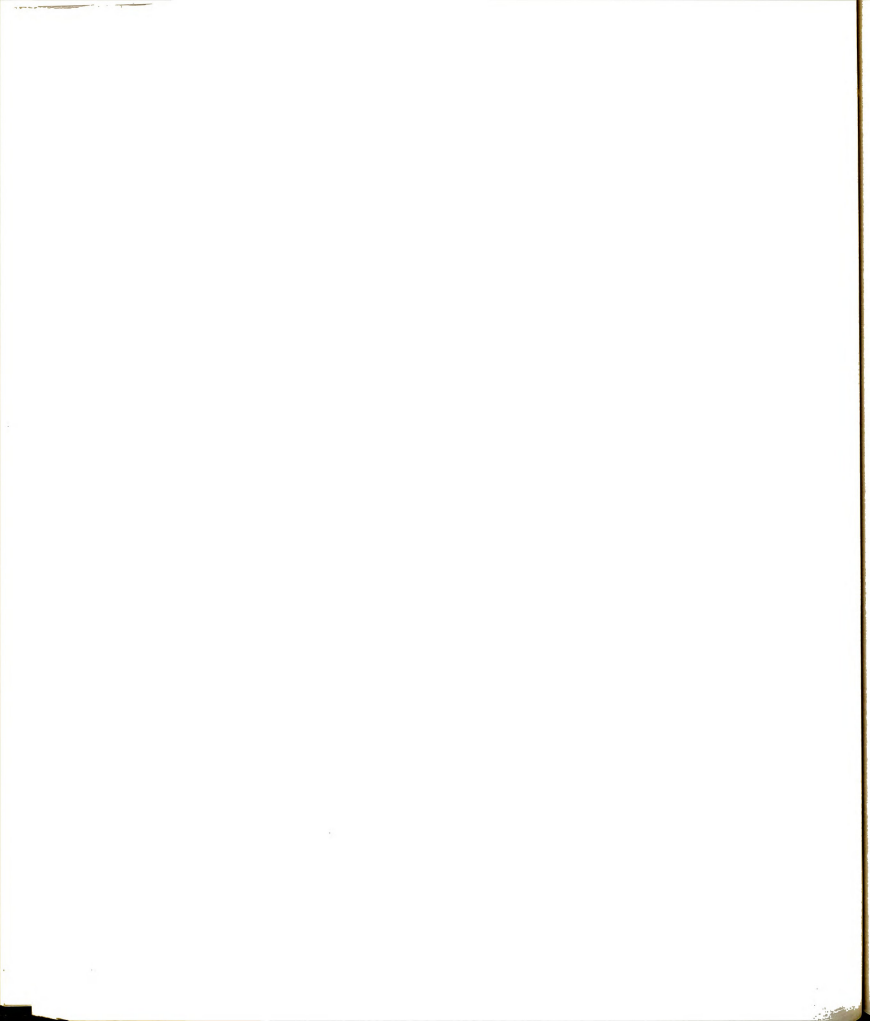
The machine as a key element only pays dividends when it makes possible the creation of more wealth than it consumes. Machines are expensive resources that add to costs every hour that they are not productively employed. This may mean the allocation of additional manpower and management to keep the machine maintained and busy. Even under almost impossible subsistence-level farming and short-term credit, private purchasers of tractors in Thailand have been able to pay for modern wheel-tractors too large for their traditional small farms by hustling and by applying the principle of "mechonomics."

Chancellor (1970) points out that four men in Thailand are used to operate a tractor and keep it busy. If necessary, the three drivers operate it 24 hours a day



while a fourth man spends full time scouting for more work. Two of the drivers also double as mechanic and as cook. The flexibility of this system permits any man to do any job necessary to keep the revenue coming in to pay the operating bills and the purchase payments. Good management and flexibility also require that the machine be used in one area as much as possible for efficiency; but when the rate of return decreases, the machine is moved to another area where opportunities are greater. This illustrates how the concept of mechnomics works. Excellent management is essential. It must be practiced by all operators even to the sacrifice of personal desires when timing is critical or work loads demand. Larger organizations can hire others to do some of the less pleasant or more arduous tasks; but such employees must be wisely selected, thoroughly trained, and continuously supervised. Otherwise man will neglect his machine and its job, shrug off problems and responsibilities, and let management worry about the decreasing productivity and increasing costs.

Much more attention needs to be given to the concept of mechnomics and how it can be used in developing nations to promote a vigorous agricultural growth. There is a definite place in every nation's development for the introduction of rational engine-powered agriculture. Just when and where it can be used most effectively, how it will be used, who will be responsible for its development, and

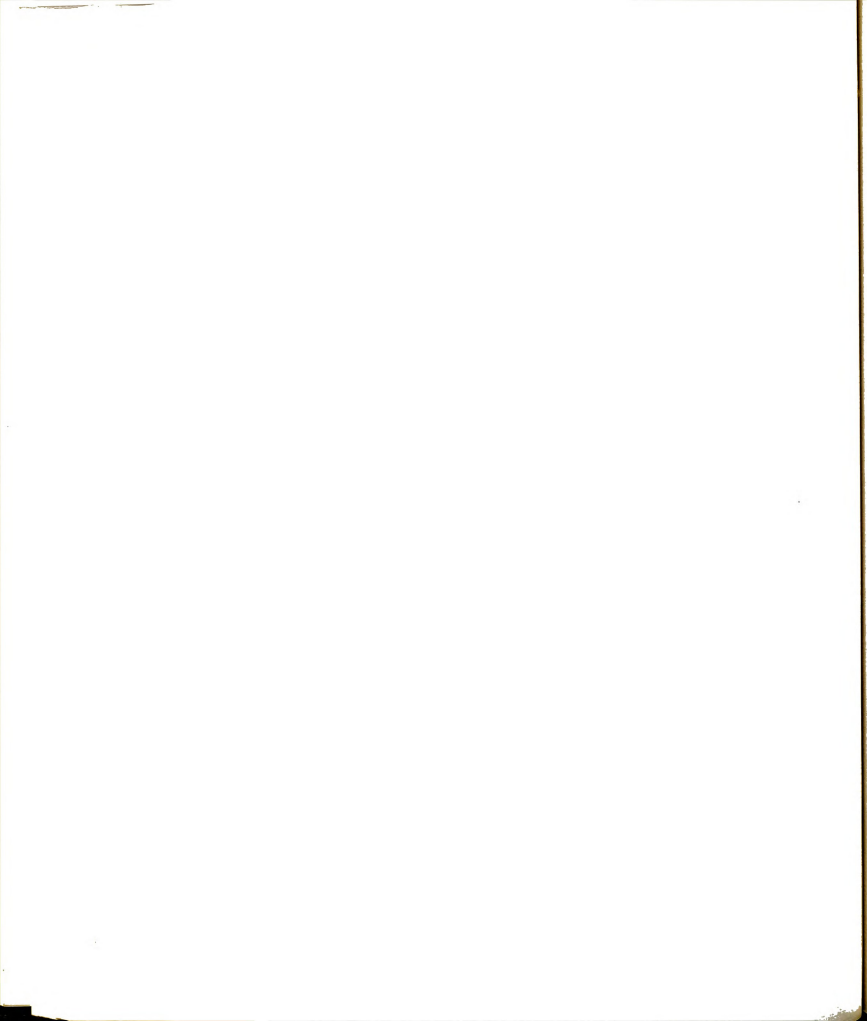


what resources will be employed are specific questions to be decided at the particular time and stage of development. Some imbalance is needed to stimulate development and to produce new markets, new products, and new ideas which in turn will lead to further expansion and development. The concept behind mechnomics continually creates more intricate and complicated machines requiring more systematic and complex management by more highly skilled and responsible men.

Recommendations for Further Research

Suggested Follow-Up and Overseas Testing of the Basic Tractor Operator's Course

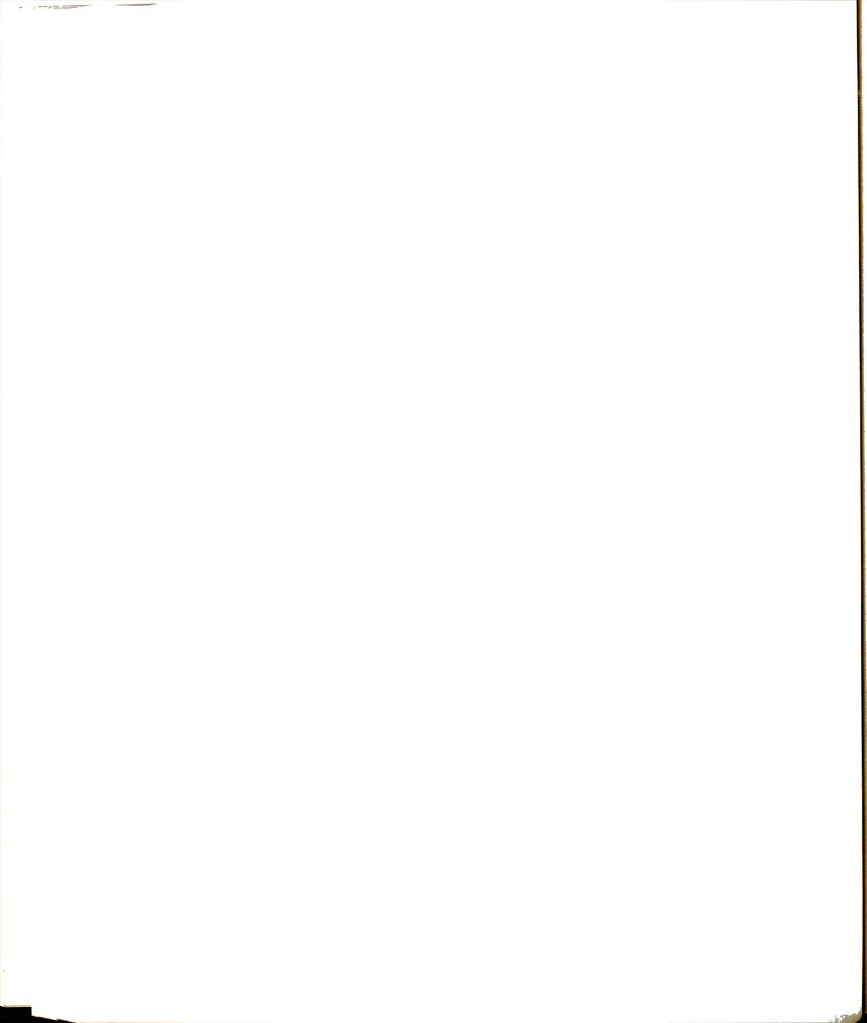
The preliminary test of the BTOC with migrant workers of Spanish descent indicated that the training program will work across cultural boundaries. How well it will serve in a foreign country when administered by local trainers to their own people is yet to be determined. The migrant workers trained in this preliminary testing program had more mechanical background than is normally found in overseas rural trainees or middle school leavers. The fact that many U.S. migrant workers use automobiles in moving from job to job gives them a decided advantage in familiarity with mechanical devices. Overseas testing is needed to determine whether trainees with little or no mechanical background can be trained as successfully in developing countries.



The BTOC was built around a medium-size (50-60 hp.) modern diesel tractor because this is the most popular size in rapidly developing countries as well as in most of the U.S. As a next step, the content of the BTOC should be adapted to other brands of tractors and self-propelled machines for more general application of principles.

Because of withdrawal of funds, the overseas testing phase could not be carried out during 1970 when this research was conducted. The initial testing program should be continued with a carefully planned random-block experimental design in at least two countries. Trainees should be selected by some form of random cluster sampling to get a true cross-section of the low-education and disadvantaged groups for comparison with other pretested select groups. After identification, the trainees of the random sample should be brought together and evaluated objectively, using the best techniques and instruments available. It is suggested that the new U.S. Employment Service Special Aptitude Test Battery or similar tests be used to measure each trainee's apparent aptitudes under identical conditions. This test should be supplemented with interviews and consultation to help establish the trainee's educational and work experience background and entry level into training.

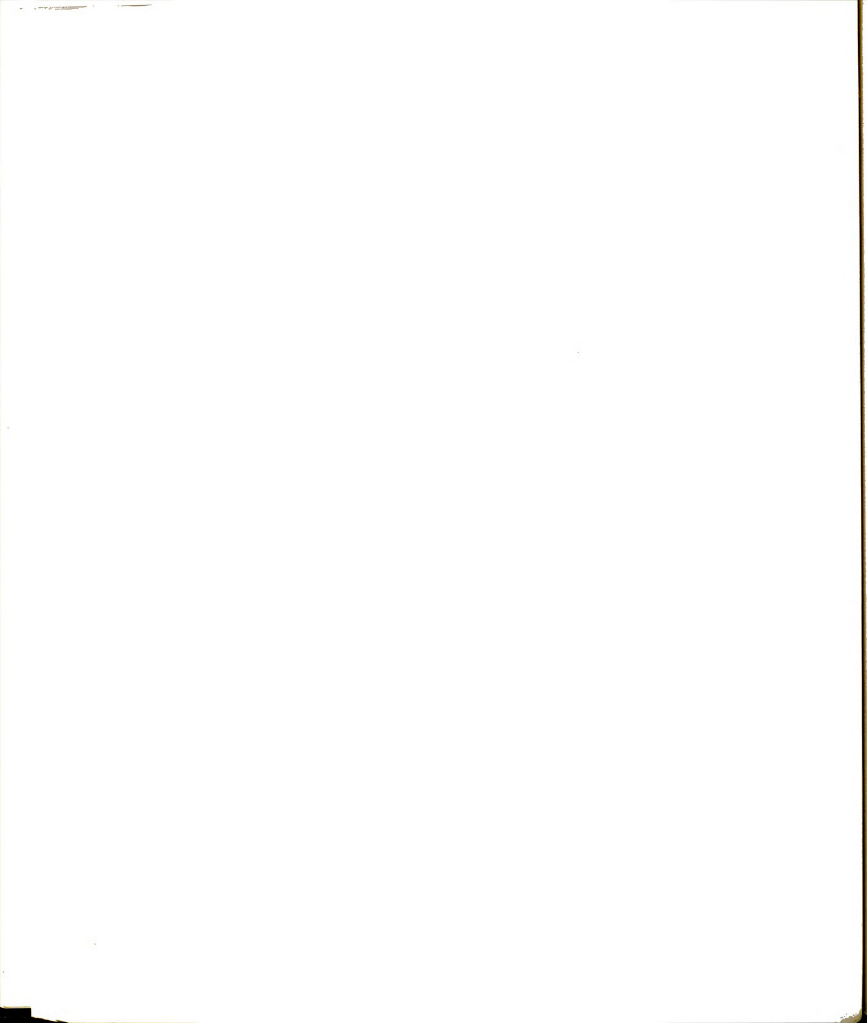
It is suggested that the follow-up testing program be conducted in one African and in one Asian or Latin



American country. In Africa, the most favorable site is at the Narosurra Mechanization Training Scheme in Kenya which could draw students from member nations of the East African Community (ECA). This large, privately operated farm and training center has already had considerable experience in training African farmers in modern agricultural practices and has indicated genuine interest and a desire to cooperate on a testing program. With a large number of applicants waiting to enter their regular three-months' mechanization course, random sampling could be used to identify a test group to receive training in the Basic Tractor Operators' Course.

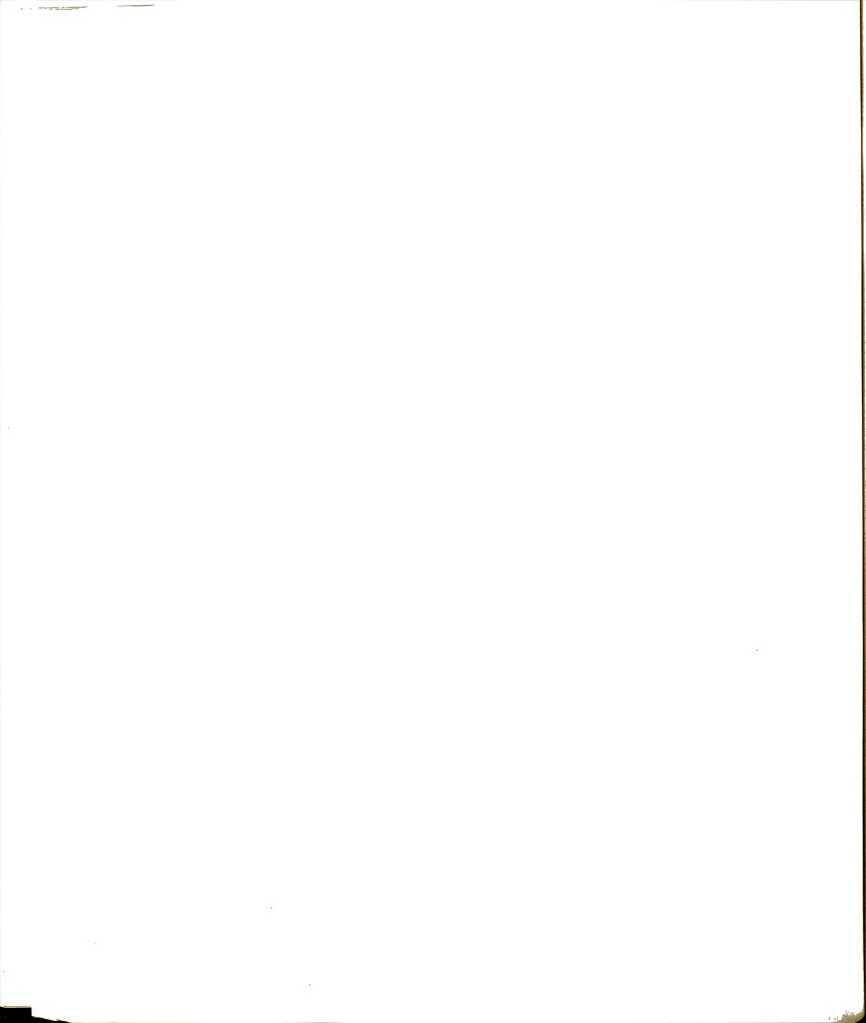
Since other students will have just completed, or may be concurrently taking training under the Narosurra program, a direct comparison could be made between the two groups trained under the same environmental and cultural conditions. The pretests and/or post-tests of the BTOC could be given to both groups of trainees, in addition to the final evaluation events, to measure the attainment of objectives and qualification as Basic Tractor Operators.

A second similar testing program could be held in Argentina, Brazil, Columbia, or Mexico in Latin America, or in India, Iran, Malaysia or Thailand in Asia. Comparisons could be made between cultural groups and within cultural groups when other training programs are offered from which students could be evaluated.



Each testing program should be analyzed in two phases: First, measurements should be made of the effectiveness of selecting and training local teachers in a condensed but intensive instructors' training program. The instructor trainee should actually teach bona fide students and should be rigorously examined by outside evaluators on learning methods, teaching techniques, subject matter, communication, and practical skills. The instructor should be able to perform every skill at least as well as he expects the trainee to do it. The instructor who cannot demonstrate how to do a specific task, and how well it should be done, has no place in vocational technical applied learning.

Second, the new instructors should be helped to identify the trainees, analyze their entry level, and observe their training in the regular full-length Basic Tractor Operators' Course. The outside coordinator can assist in pretesting the trainees and getting the instructors off to a good start. It is most desirable that the new instructor have a successful experience with his first class. He will undoubtedly need to be guided and prodded to keep him on the right track. If the instructor is not careful, he will drift back to old lecture habits, will neglect daily evaluation, and will fall into a lock-step process without individualizing the instruction and keeping it practical and on schedule. The outside evaluator should

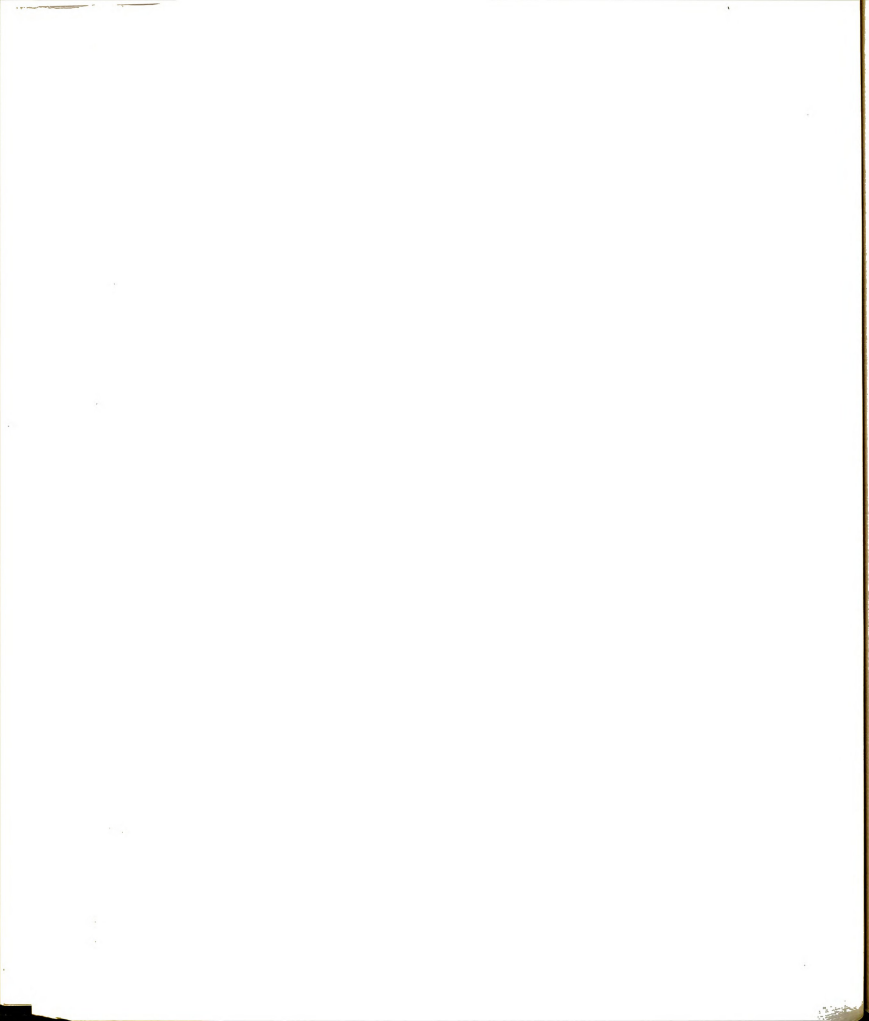


not interfere with the instruction but should make sure that problems are resolved before they impair training. The lesson plan and schedule must be followed, to permit a comparative evaluation of the total training program.

Follow-Up Courses for Up-grading Tractor and Machinery Operators

Material for the proposed Advanced Tractor Operator Course, Combine-Harvester Operator Course, and Crawler Tractor Operator Course has not been developed at this time but is suggested as a follow-up to this work. It is suggested that these courses can be patterned after the Basic Tractor Operators' Course and developed as complementary manpower training. A brief description of the possible nature of these courses follows:

Advanced Tractor Operator, Grade II (1-2 Weeks' Refresher Course) This follow-up and refresher training program should be designed to up-grade the Basic Tractor Operator, Grade I to the more advanced operator or owner/operator stage requiring greater self reliance. The Grade II Operator should be qualified to perform additional maintenance and service on the tractor, including some minor adjustments and simple repairs. Instruction should be carried out on the use of additional tools and implements with special emphasis on PTO and belt-pulley operated implements and equipment. New developments in farm machinery and agricultural production practices should also be stressed.

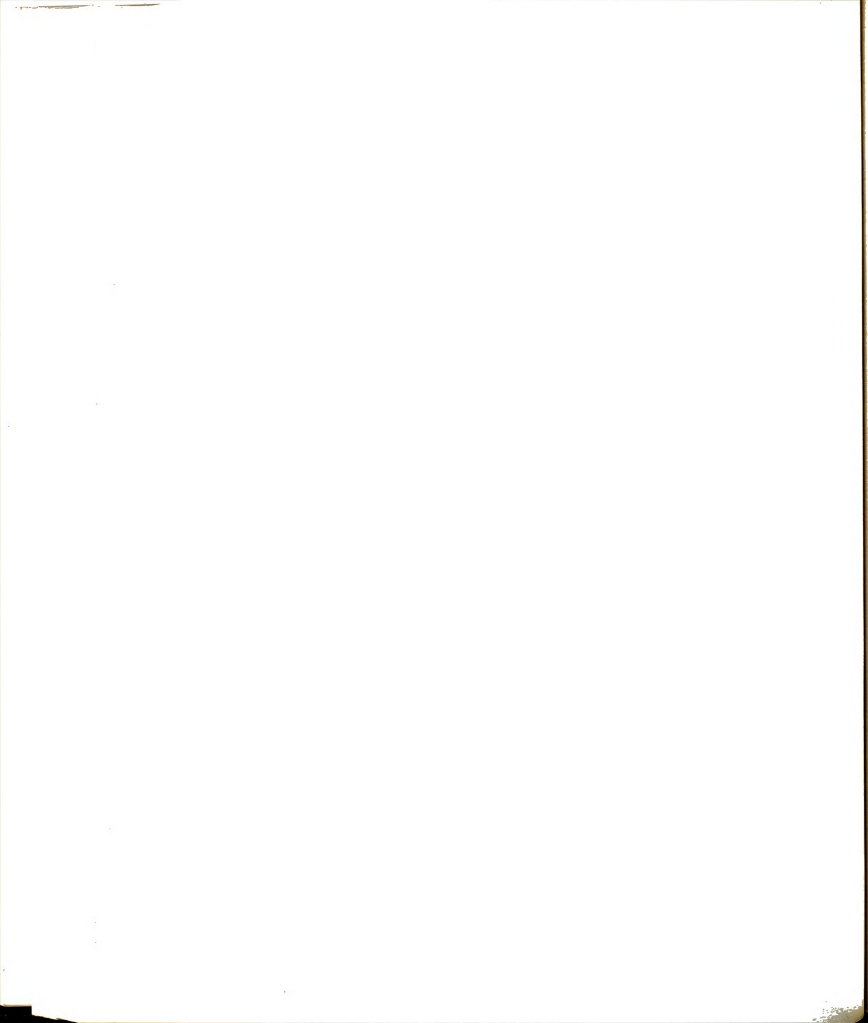


Fully Qualified Tractor Operator, Grade III (2-4

Weeks' Contractor/Supervisor Course) This training program should cover all tractor preventive maintenance and lubrication services through 1,000 hours. It should also instruct the trainee in the operation, adjustment and care of all major tools and implements used in the area. Skills and knowledge should be developed which are sufficient for independent operation of the equipment. This operator should be able to make all minor adjustments and carry out all routine repairs and service. He should be capable of making managerial decisions contributing to the wise and efficient scheduling and use of the tractor and its associated implements and tools. The Grade III Tractor Operator should be qualified to operate as a private contractor or tractor-hire service. He could supervise from 5 to 10 Grade I and II operators in a mechanization project, tractor-hire service, or large commercial farm or plantation. He should be able to follow written instructions and carry out the recommendations given in the owners' manuals and instructional materials.

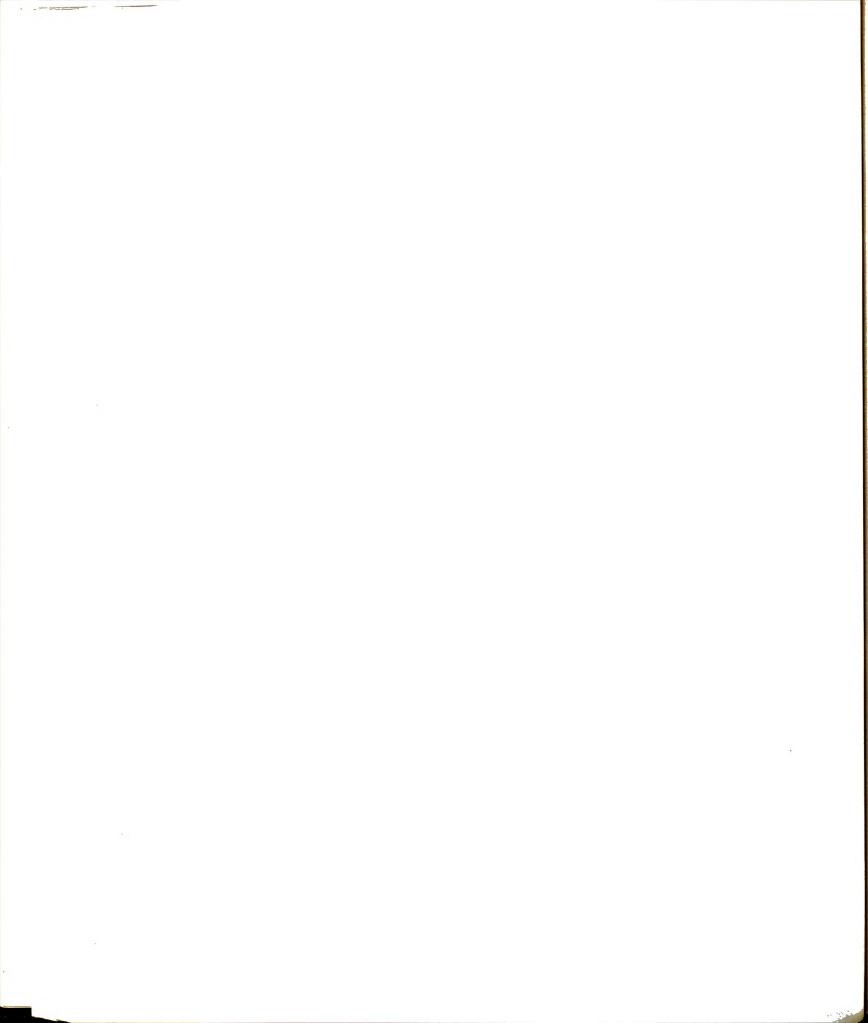
Combine-Harvester Operator, Grade I (2-3 Weeks'

Course) This course should train the graduate of a Basic Tractor Operators' Course to work with special grain, fiber, or commercial food harvesting and processing machinery such as small grain combines, maize picker-shellors, cotton harvesters, or specialized harvesters for crops such as



tomatoes, cherries, and apples. The operator should be given special fundamental training in crop characteristics, harvester adjustments, operating techniques, crop conditioning problems and machine and business management. The trained operator should be able to completely service the machine daily, make major adjustments and minor repairs. He should understand the principles of operation of the separating and processing mechanisms so that he could solve common problems and adapt the machine to changing field, crop, and environmental conditions.

Crawler Tractor, Wheel-Dozer, Motorized Scrapers, and Similar Machines, Grade I (2-4 Weeks' Course) The graduate of the BTOC could take training on any of these basic earth-moving and shaping machines. Many special schools offer training programs in the heavy construction field. It would not be the purpose of this course to compete with any of these programs. A special course could be offered, however, in the major rural problems of building farm ponds, small-scale earth dams, terraces, revetments, levees, drainage and irrigation structures and similar agricultural water and erosion control facilities. The trained operator would learn how to make work estimates, price out jobs, work on a schedule and follow specifications. He would be trained in the art and basic science of making cuts, fills, excavating, hauling, packing, and

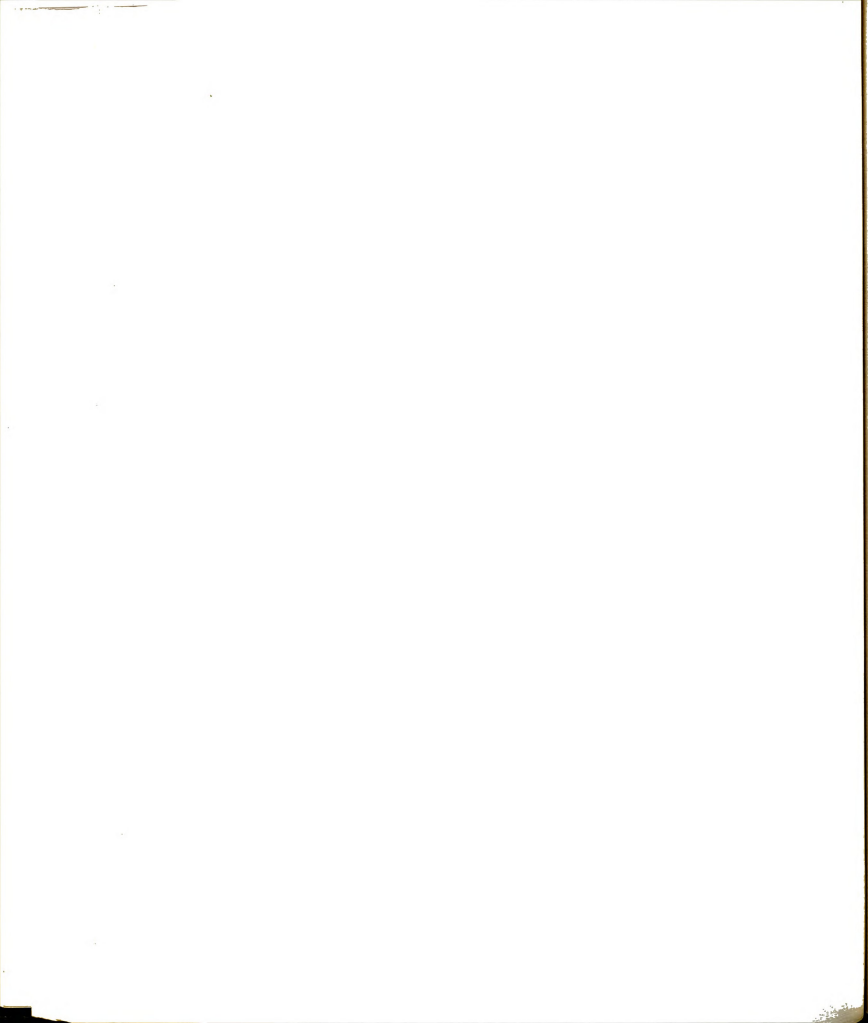


otherwise moving and reforming large volumes of earth and rock. After graduation he should be qualified for employment and, with sufficient experience, to set up his own business as a rural contractor.

Verify the Validity of Current Aptitude Tests
in Measuring Trainee Potential

Selected aptitude tests should be given to all trainees prior to instruction in a standardized course such as the BTOC. A series of controlled experiments should be conducted to verify the hypotheses that certain types of standardized mechanical and non-verbal aptitude tests such as the GATB or SATB can be used to help predict which applicants of low education level and/or non-mechanical backgrounds are most receptive to training and are most likely to become qualified tractor or machinery operators. At the same time, it should be verified that these tests can also eliminate those applicants least likely to succeed.

If the trainee does well in an aptitude test such as the GATB or SATB, it is hypothesized that he will also do well in a training program for machinery operators. However, some parts of the GATB may not be reliable as indicators of trainability in foreign countries. The scores of each part of the GATB or other aptitude test should be compared with the course evaluations and the final testing. Analysis should be made of the pre-training



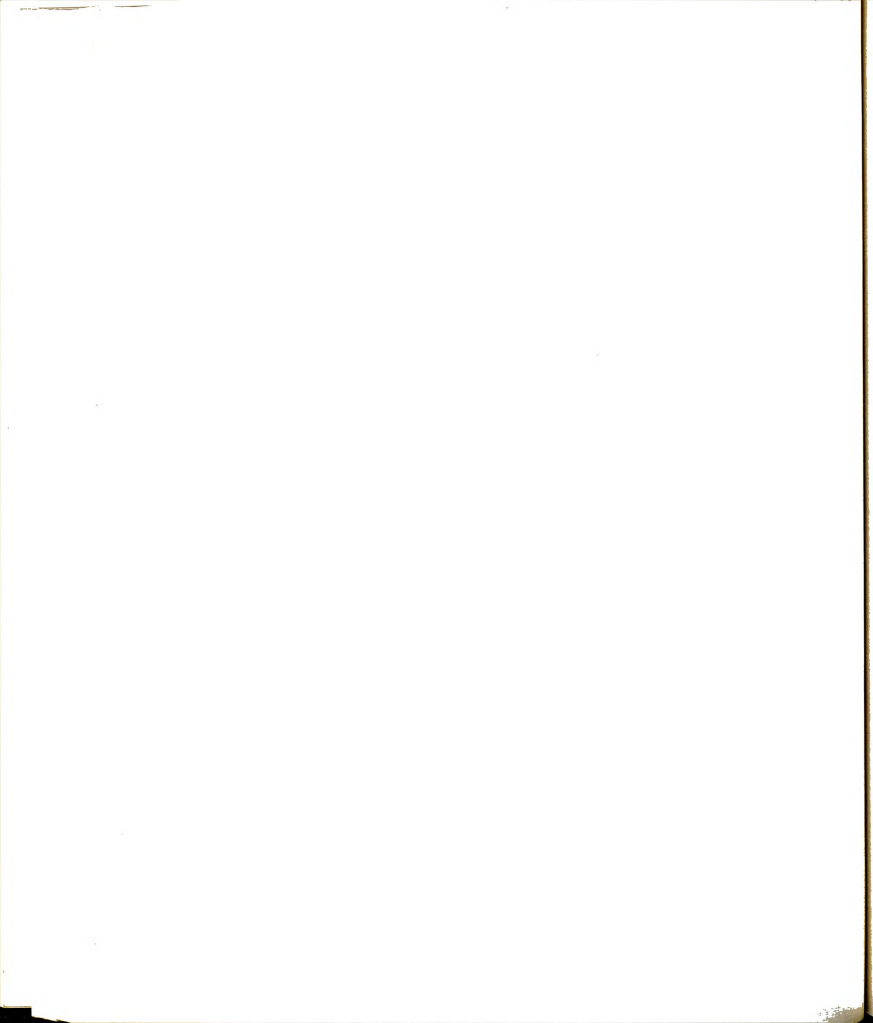
GATB or aptitude test scores and the final course evaluations to see if there is significant correlation between the high and low aptitude scores and the high and low training achievements.

If certain sections of the GATB or other aptitude tests prove valid in predicting which trainees are most likely to succeed or fail, their use would improve training efficiency and increase the percentage of successful graduates and their competence. This testing procedure could result in a considerable economy of effort and training resources and pave the way for structuring more efficient training programs.

Develop and Prove New Aptitude Tests
for Trainees with Low-Education and
Non-Mechanical Backgrounds

If currently available standardized aptitude tests are proven unsatisfactory for measuring undeveloped capabilities in trainees from other cultures, new instruments should be developed. A proposed general mechanical aptitude indicator for trainees with little formal education and/or experience with mechanical devices was prepared but not tested as a part of the Basic Tractor Operators' Course.

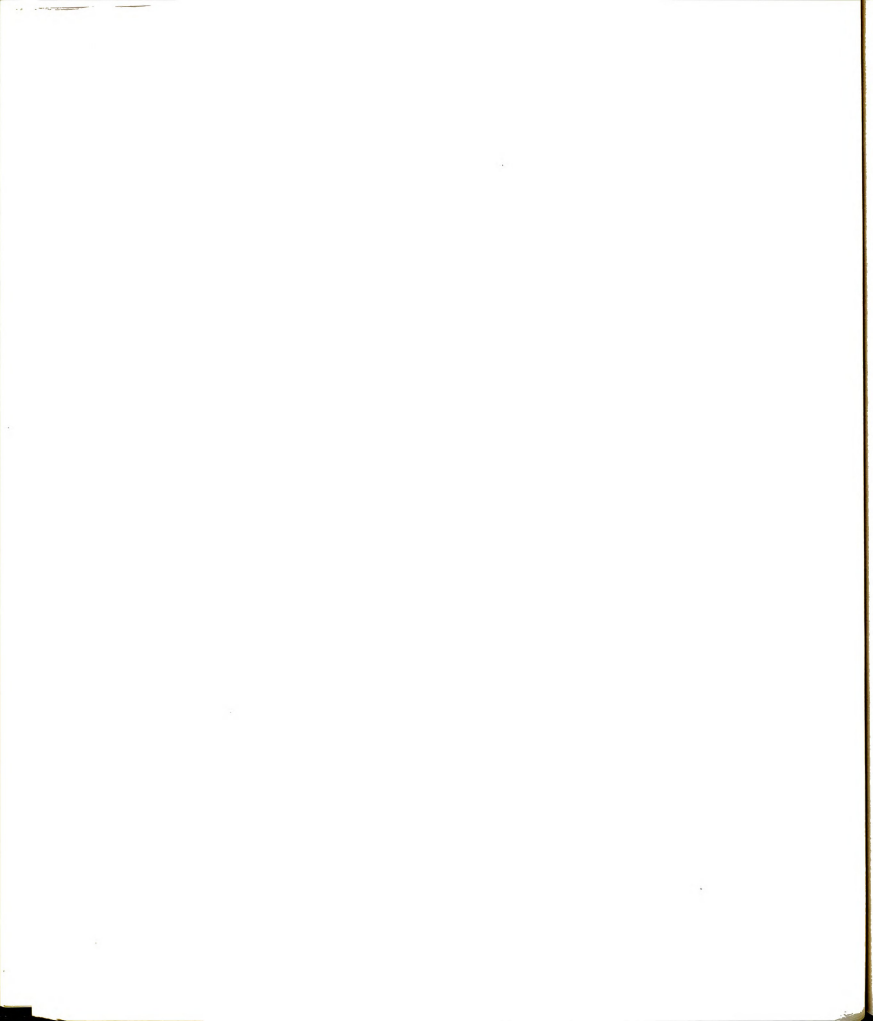
The objective of such a test should be to discover which applicants possess desirable and discernable mechanical aptitudes which can be amplified by training. Such a test should pinpoint trainees with unique aptitudes or combinations of aptitudes who could be readily trained in the



skills for several mechanical and technical vocations. Each vocation could lead from the simple to the more complex occupation such as from tractor driver to mechanic or field supervisor.

The proposed simple aptitude test should be made up of pictures and drawings of various types of simple and common tools and devices and their parts. Not all items will be found in all countries and some may have slightly different forms than those suggested on the test instrument. However, each country's coordinator should be able to substitute other items which would be more appropriate for his own culture and locale.

The proposed non-verbal cross-cultural aptitude test would be used to weed out persons exhibiting little mechanical inclination and to select only those potential trainees who have pronounced and desirable general intelligence and mechanical traits. The degree to which applicants possess such latent ability may require that strictly rural youth be compared only with each other; similarly, that city youth be compared only with their peers. Such tests, dealing with very simple and common mechanical devices and calling for perception and judgments about the nature and functions of such devices, should measure general capability.

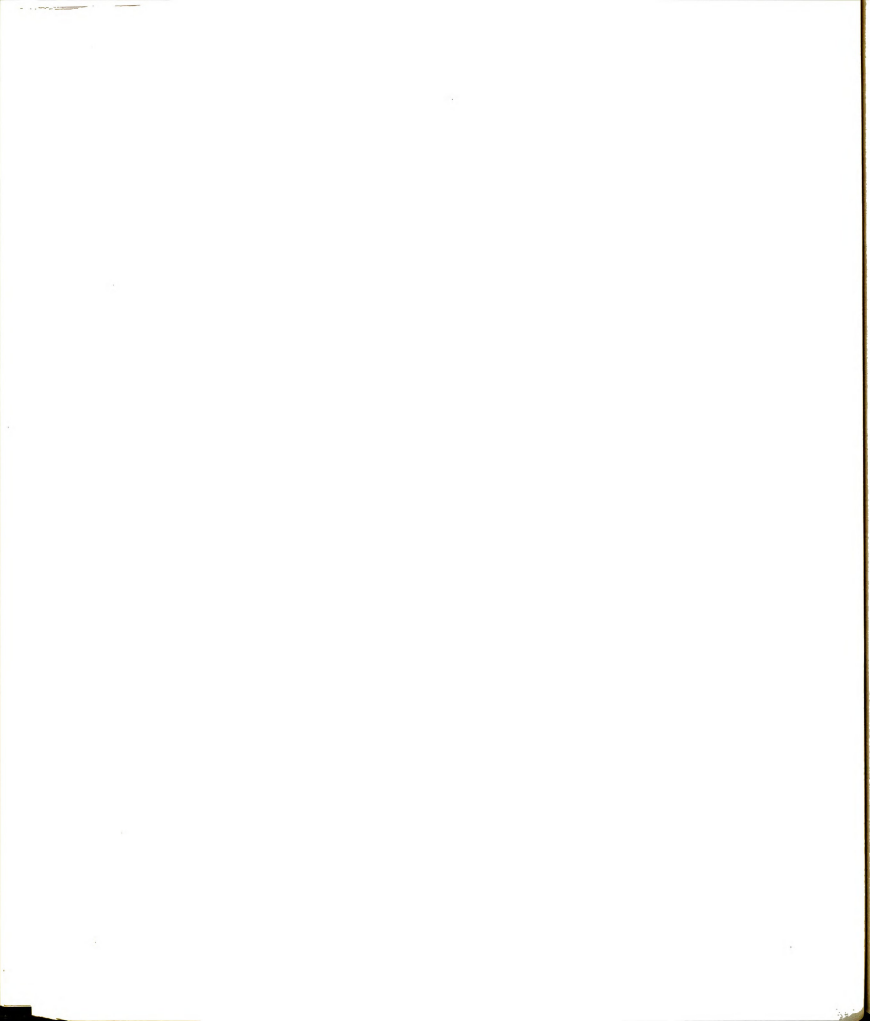


Comparison of Costs Versus Benefits of Untrained
and Trained Machinery Operators

Surveys and studies conducted in Asia and Africa have reported that efficient mechanization of agriculture is largely still a pipe dream. The life of imported machinery is extremely short, and the cost of operation is disproportionately high because of mis-application of the machinery and the way in which it is maintained and operated. Tractors improperly used and maintained soon break down after only a few hours of use. Repairs cost several times the normal rates. Hard-to-replace parts such as tires and batteries are quickly damaged beyond repair, and the life expectancy for the complete machine is less than half that attained in developed countries.

It is believed that machinery operated and maintained by qualified operators will last much longer, require fewer repairs, have a lower operating cost, and produce at a higher hourly output rate than will machinery used by drivers who are poorly trained by the traditional methods now in use throughout most of the world. However, no data on controlled experiments comparing the costs to benefits of trained operators versus untrained drivers are available at this time.

Much information could be obtained from model farmers, private contractors, government mechanization schemes, development bank projects, and UN special



development fund projects in Asia, Africa, and Latin America. Agricultural machinery manufacturers could initiate controlled experiments in cooperation with educational and research institutions to prove the degree to which training pays. Every project manager knows that untrained operators increase costs considerably. However, there is no verified evidence to determine how costly it is not to train and use qualified machinery operators. Possible courses of action to secure such information are:

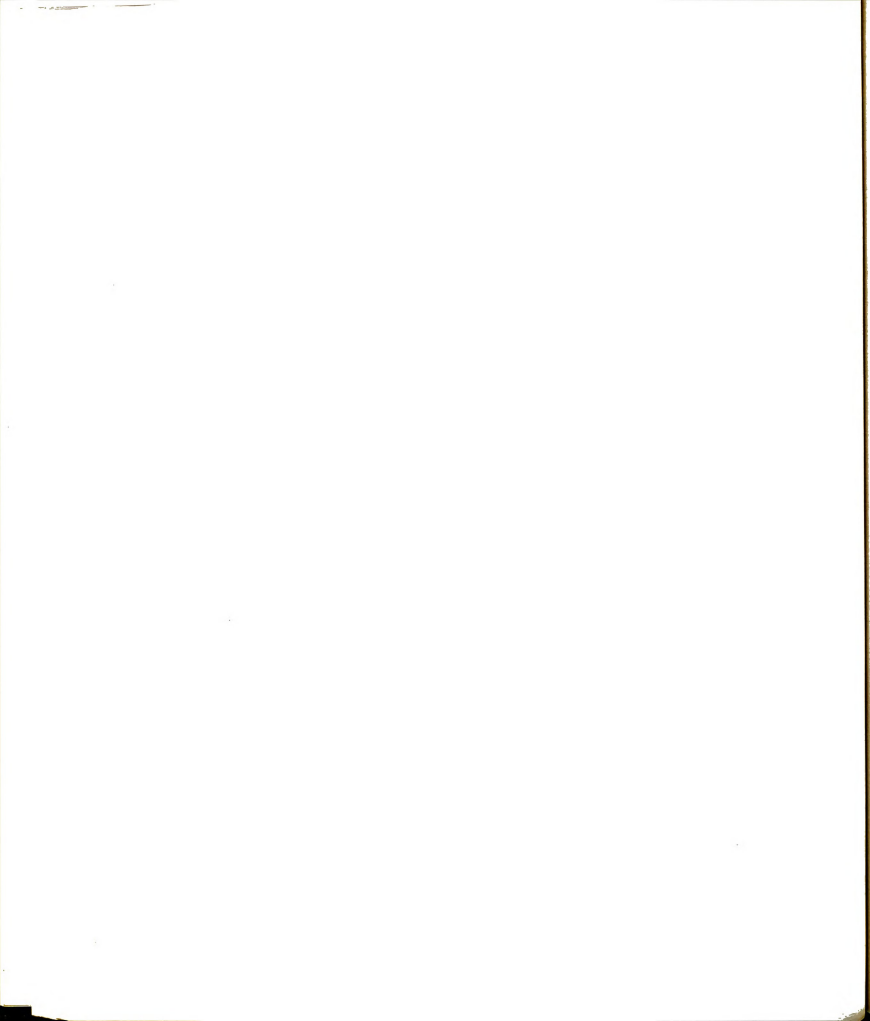
1. Initiate research to determine and record operating and service costs on machines operated by untrained or inadequately trained drivers.

2. Keep operating and service cost records on tractors and machines operated by graduates of courses such as the BTOC under similar conditions. Also obtain repair and service cost records on tractors and machines operated by graduates of any other specialized mechanization training programs, such as Narosurra in Kenya.

3. Compare the job performance, work output, service and repair costs among the groups above.

Comparison of Total Costs of Combine and Tractor Operations by Trained and Untrained Operators and the Effect upon Logistical Support

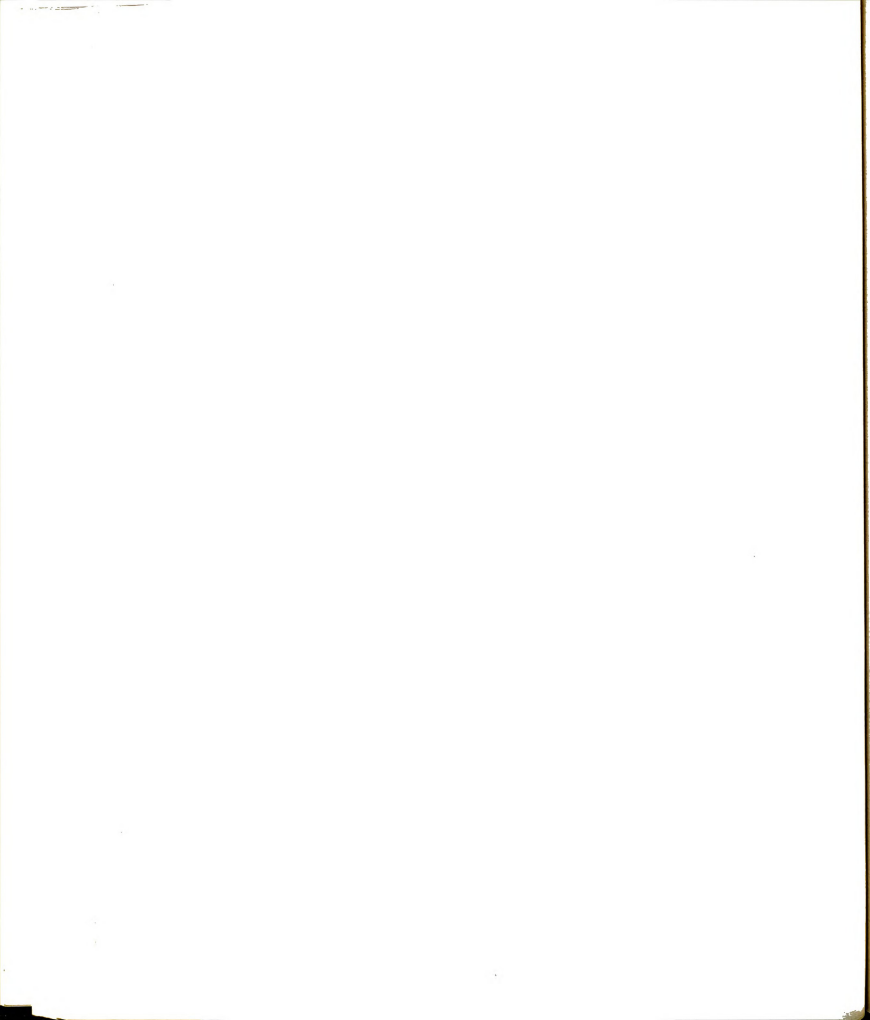
It is suggested that a study be initiated with dealers of major farm machinery who have or can get accurate records on the costs of repair and maintenance of machines



sold and serviced by them. The study should compare the difference in costs of operating a combine or tractor under similar conditions and constraints except for the degree of training the operator has received. The objective would be to prove that the cost of training is more than justified by reduced costs of operation and increased output; or conversely that training does not make a material difference in the total costs of operation of modern machinery, and therefore does not return a cost benefit.

Similarly, a study could be made using such information as that which could be obtained from the well-kept maintenance records of such organizations as state farms in Turkey, government irrigation schemes in Sudan, and private and publicly operated contract-hire-services in Sudan, Iran, and Kenya. Such a study should include:

1. Types of repairs, when they occurred, causes, and whether they were related to operator ignorance or negligence.
2. Life expectancy of a machine and estimates of repair costs of older machines when operated by the two types of operators.
3. The amount of investment needed for parts, and the quantities needed to support every 100 machines when operated by the two types of operators.
4. The frequency and duration of breakdowns during seasonal work when machines were operated by the two types.



5. The most frequent causes of failure of combines and other machines when operated by the two types.

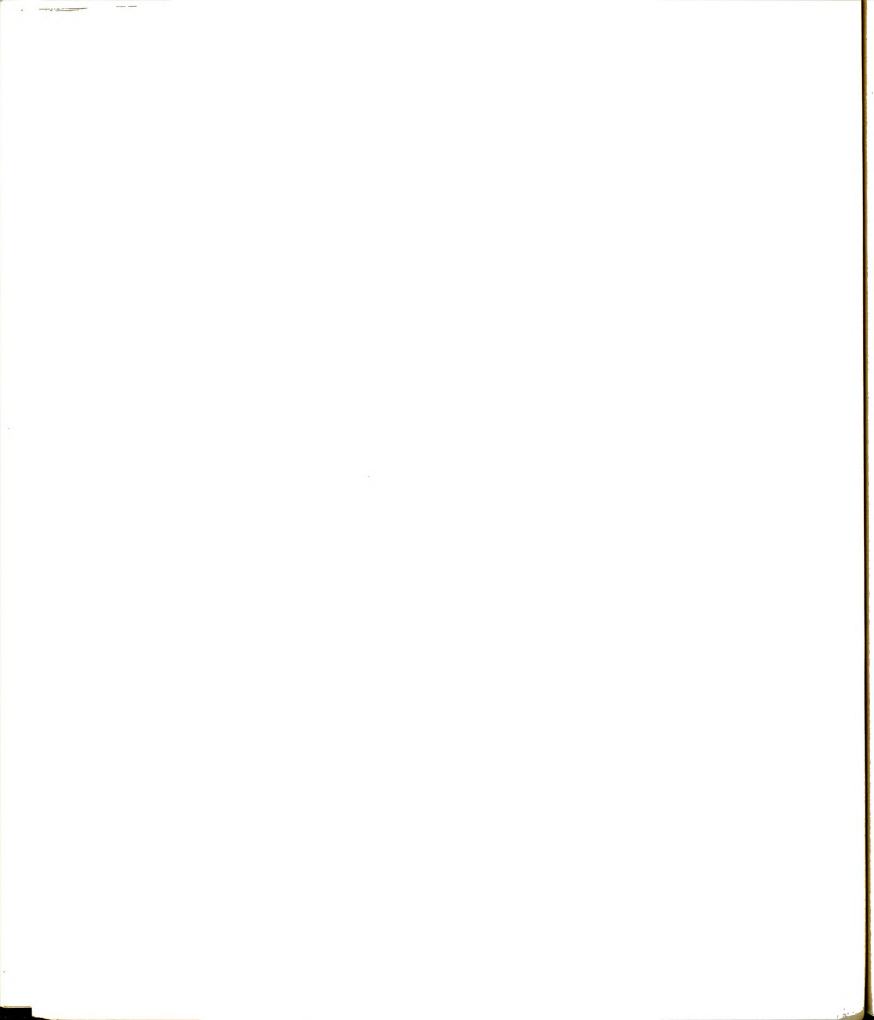
6. The type of training needed to prevent failure or to reduce maintenance and repair costs when problems were caused by the untrained operator.

7. The effect upon a dealer's service and maintenance load imposed by the two types of operators.

Improving Training Programs Offered by Manufacturers, Institutions, and Governments

Most agricultural machinery manufacturers recognize that their responsibility extends beyond the design and production of the best possible machinery for the developed and developing countries. Concurrent with making machinery available to world markets is the need to provide training to ensure its efficient and economical use. No one is in a better position to provide proper training on the operation and care of specific equipment than the original manufacturer.

For the next decade and longer, the bulk of sophisticated farm machinery will be imported into the developing countries. This puts primary responsibility for adequate training in its use directly on the manufacturer and the importer. Simultaneously, both industry and government sponsored training resources are limited by the high cost of establishing new overseas manufacturing plants to provide cheaper products and job opportunities, the increasing cost

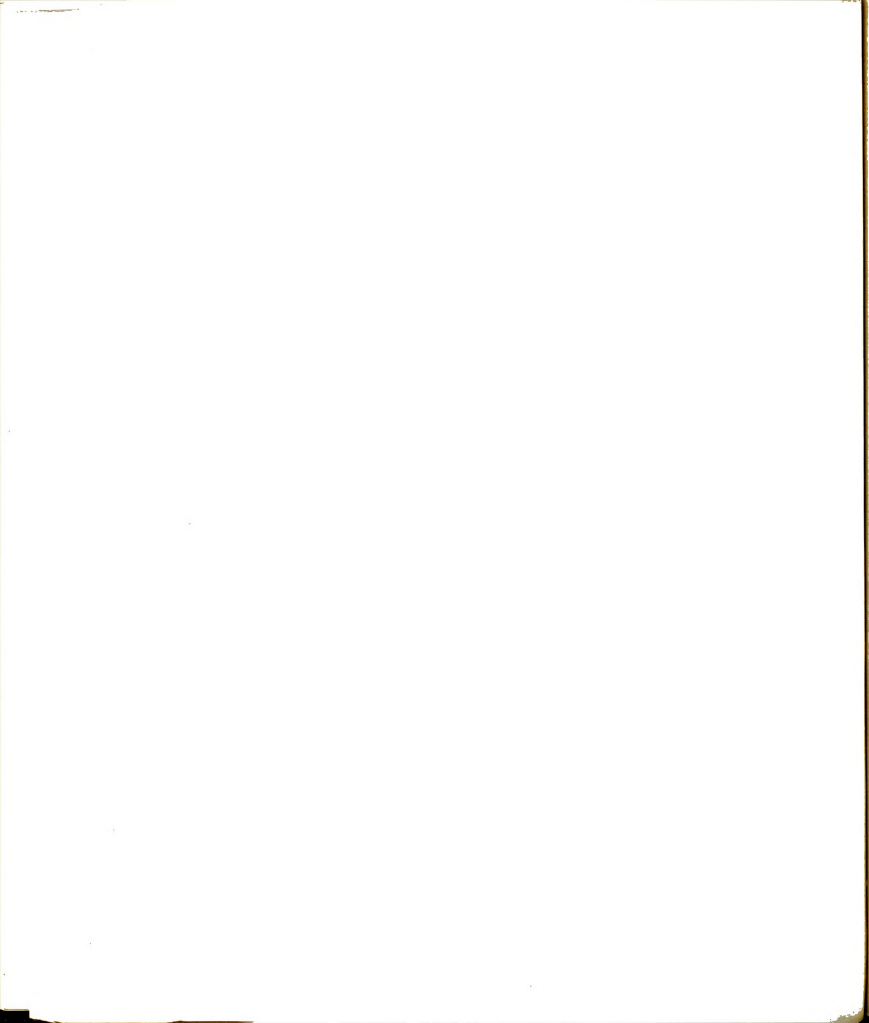


of design, the slowly developing markets, and the constraints of credit, supportive infra-structure, and lack of skilled personnel.

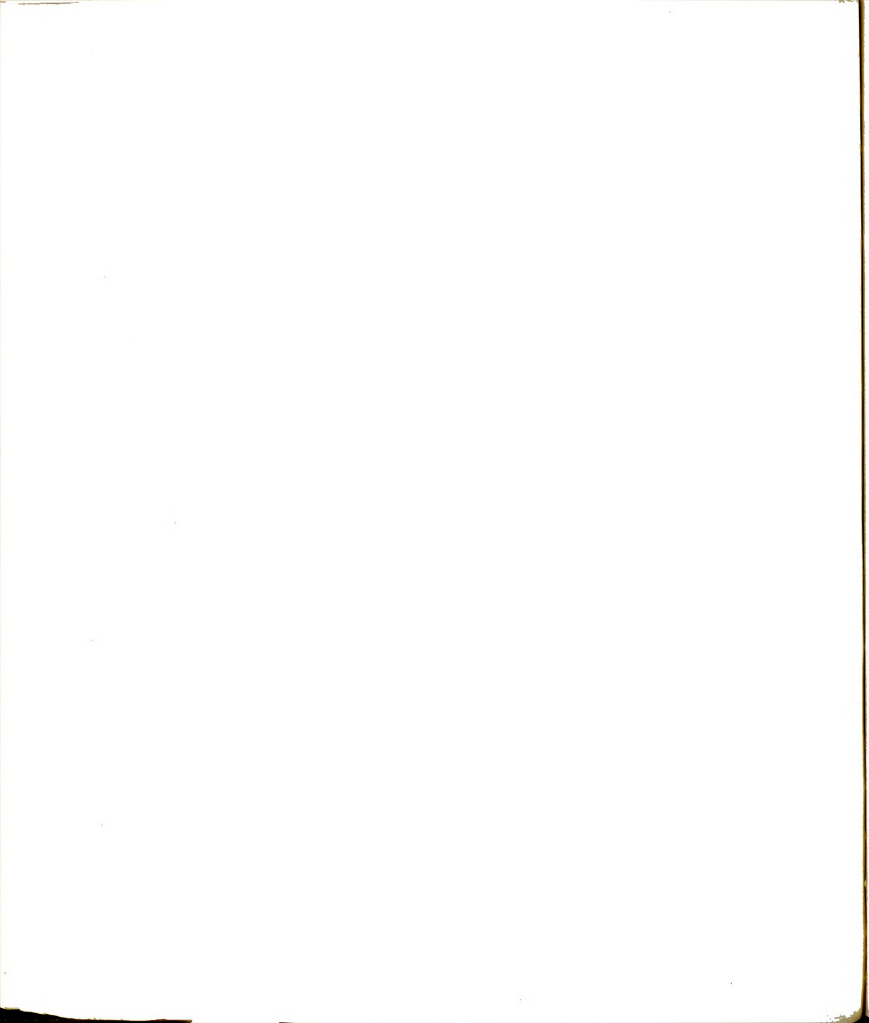
Assuming that suitable machinery is available for use in developing countries, that dealers can and will supply adequate parts and service, that governments will provide credit, price supports for agricultural products, and other policies to encourage the mechanization of agriculture,--the main limitation is manpower training. There is a large unfilled demand for qualified instructors and practical training methods prepared especially for use with the disadvantaged. Improved training skills and knowledge are needed at all levels in agriculture and in industry in both private and public enterprises.

Manufacturers cannot offer formal training to every farmer and user. Thus such organizations must work closely with government and educational agencies. For successful market development, the industry must provide some training on the operation and maintenance of its products.

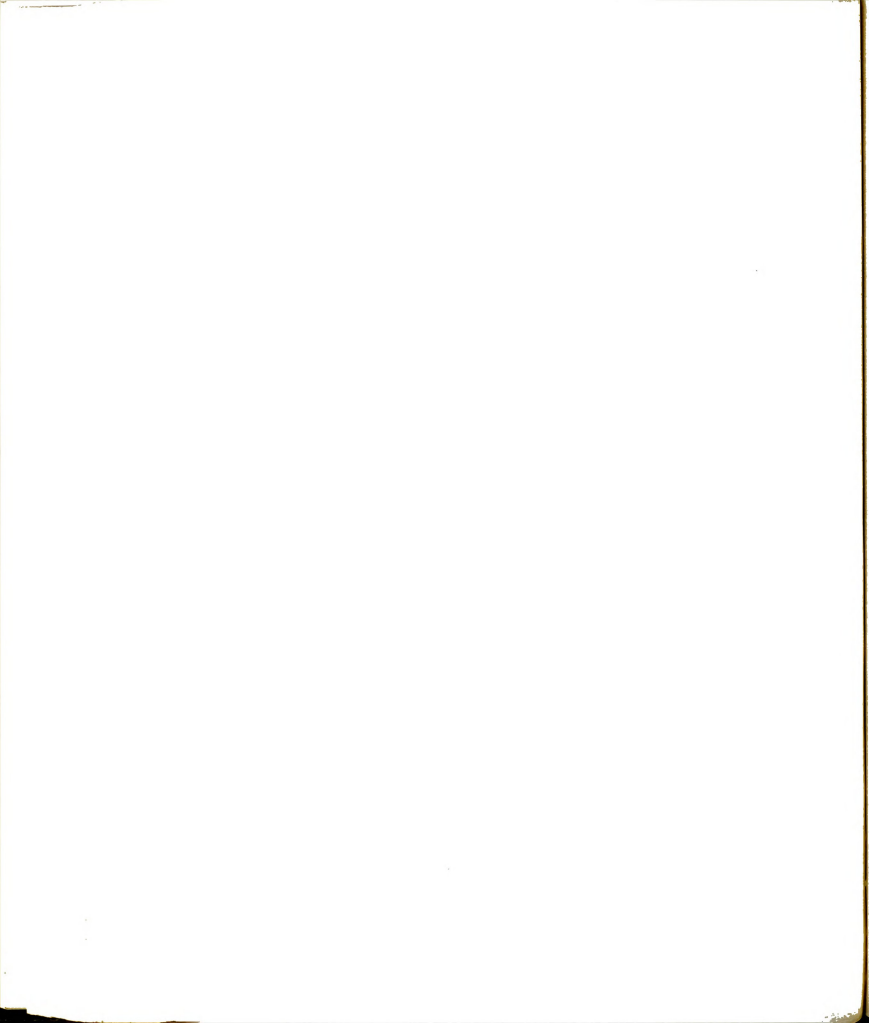
Opportunities for up-grading skills and techniques must be supported by a cooperative effort between industry, government, and educational institutions. In these efforts to improve training programs, the machinery manufacturers must take the lead in supplying facts, technical advice, and suggested training programs.



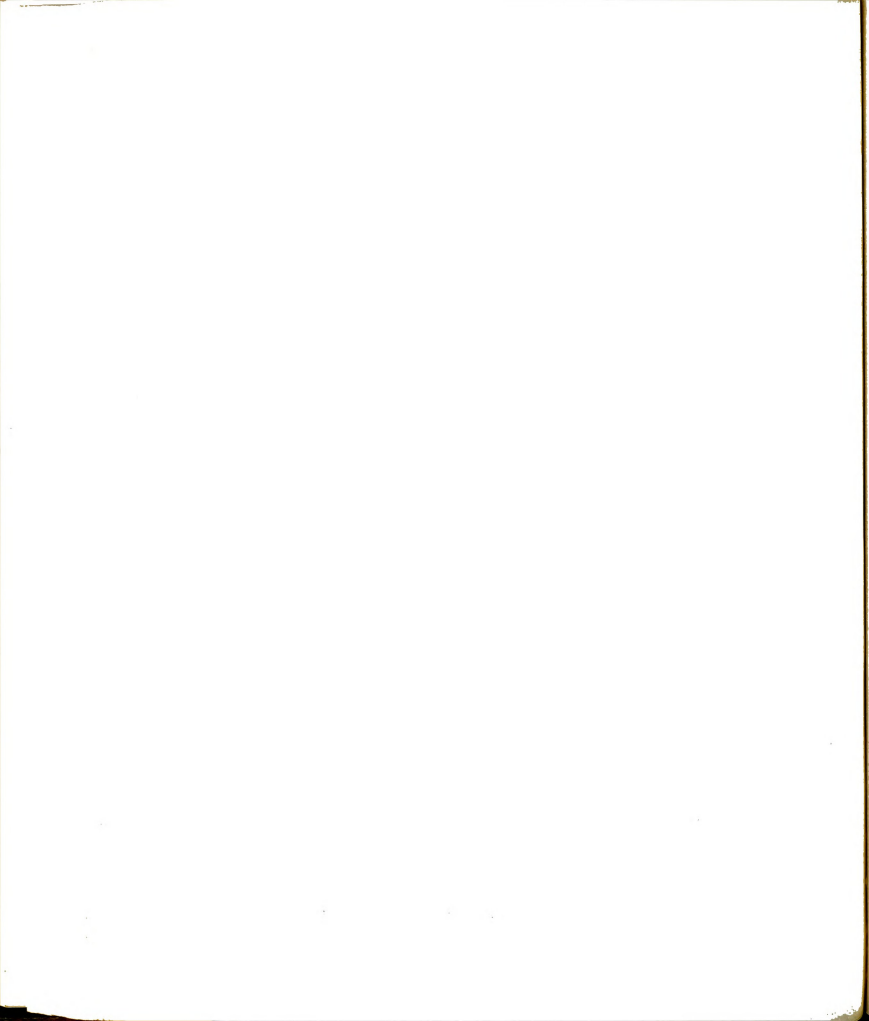
The Basic Tractor Operators' Course, supported by Deere and Company and reported by this study, is one example of a cooperative effort made by a manufacturer, an educational institution, and a state government agency. This project illustrates the possible achievements which might be attained through enlarged cooperation. Universal and more efficiently structured training programs must be designed in order to utilize limited resources to develop the latent abilities of the great numbers of disadvantaged. Such training would help to provide needed food, employment, personal satisfactions in achievement for many, and generally higher standards of living for all countries.



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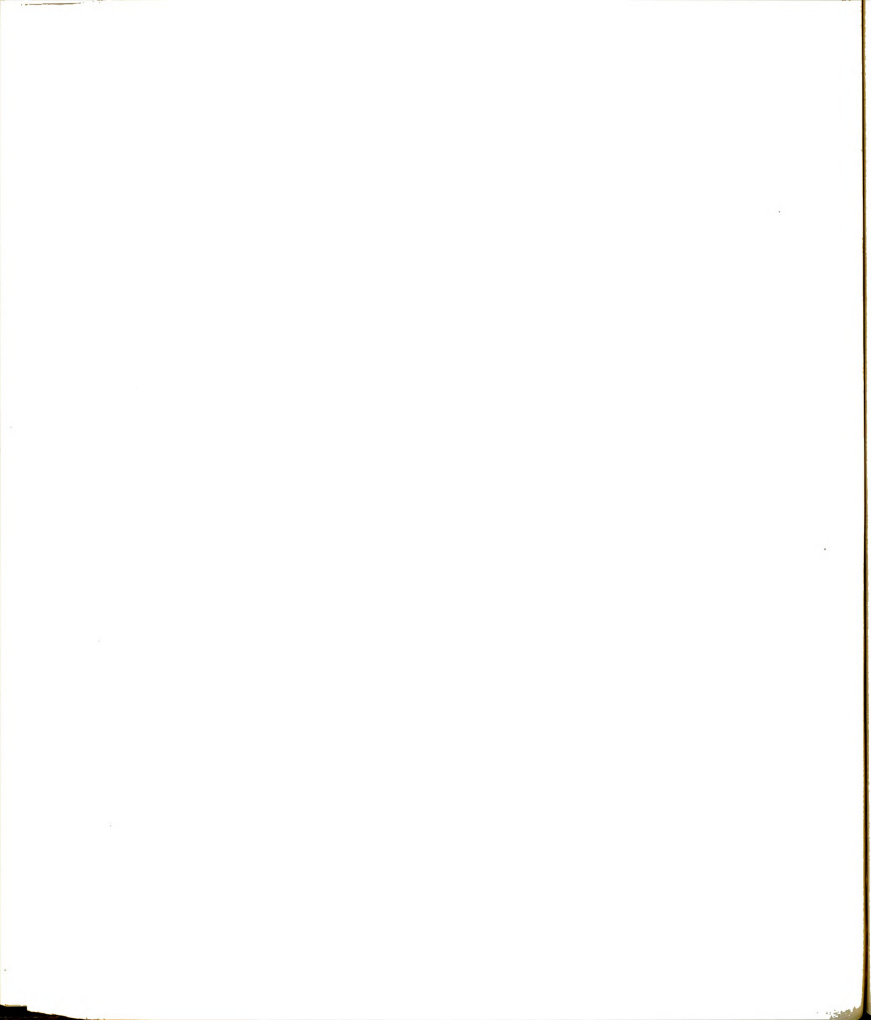


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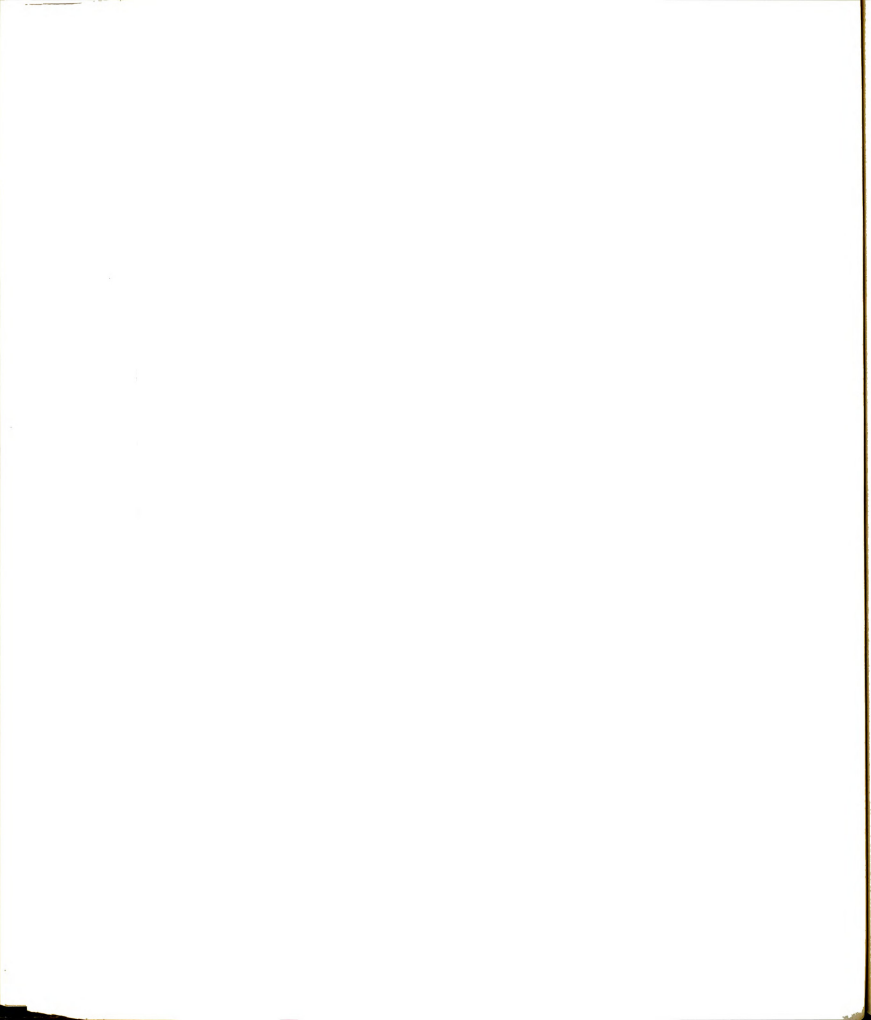


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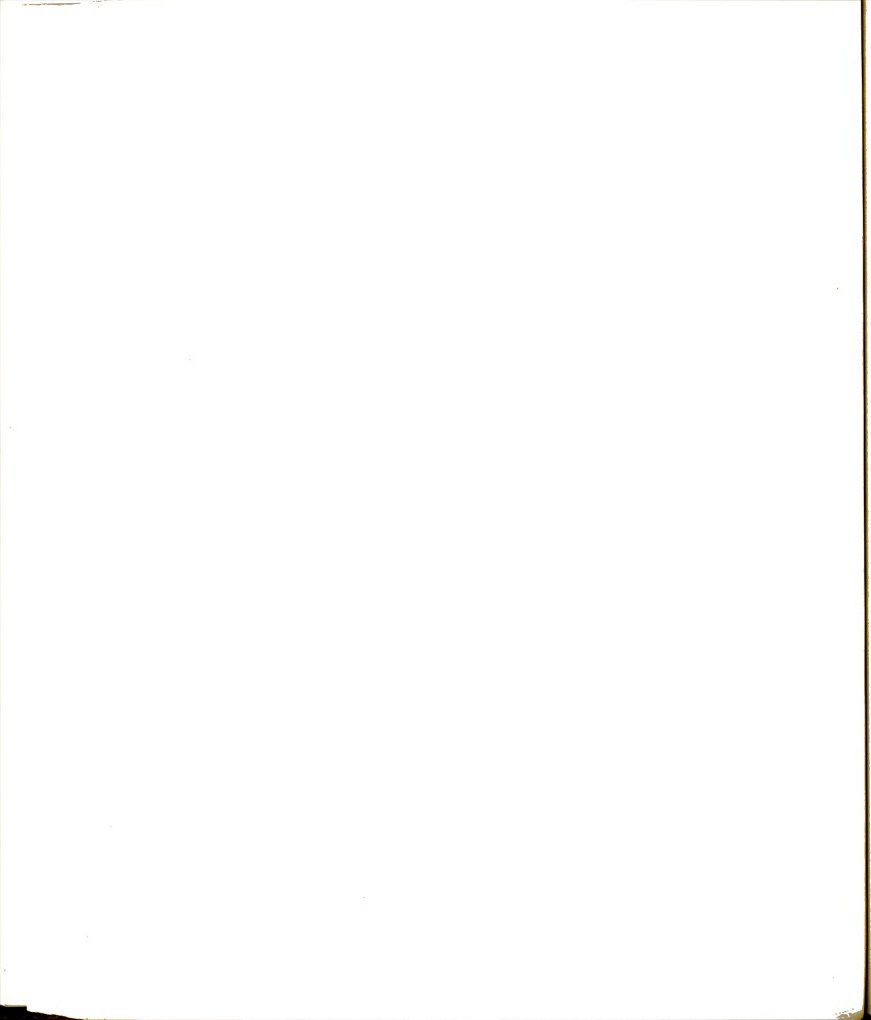
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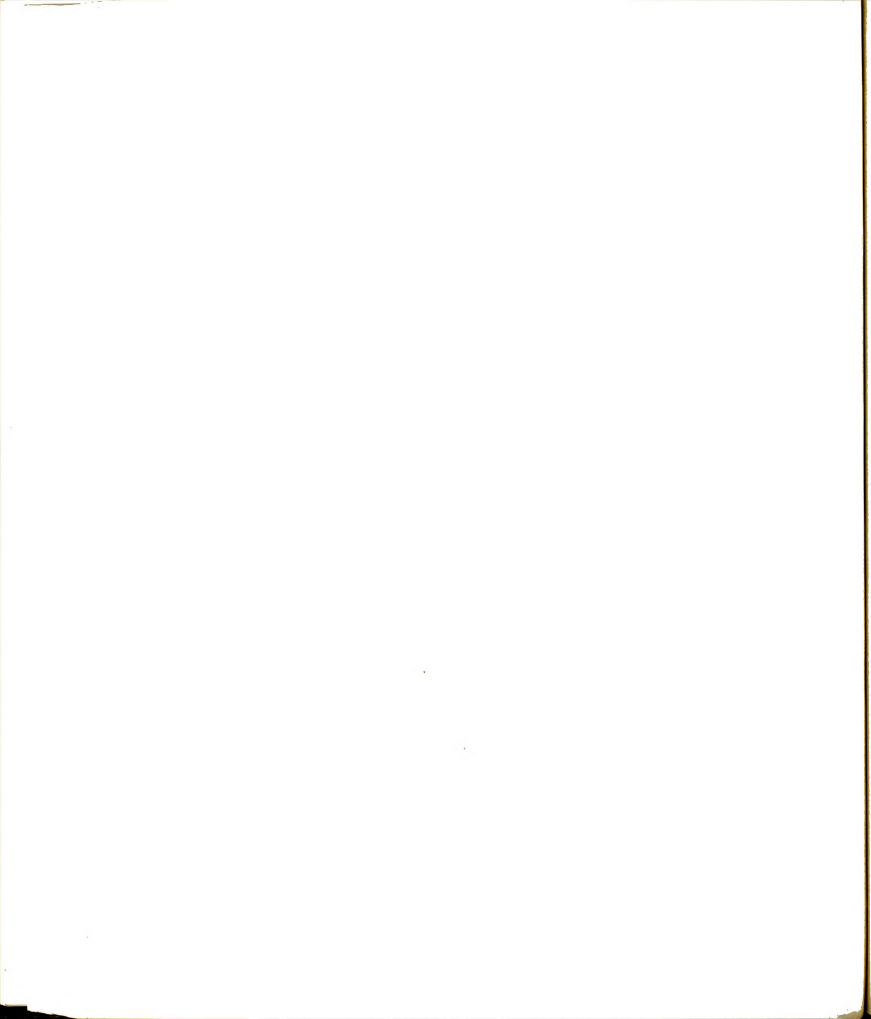
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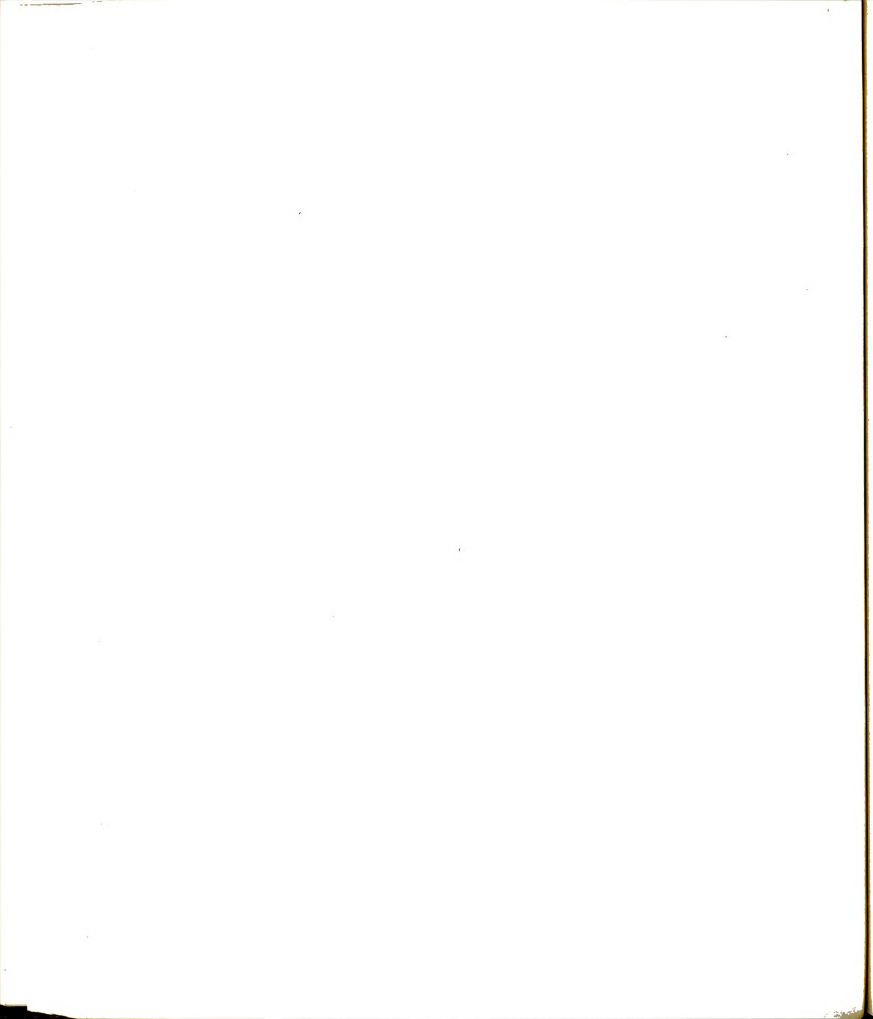
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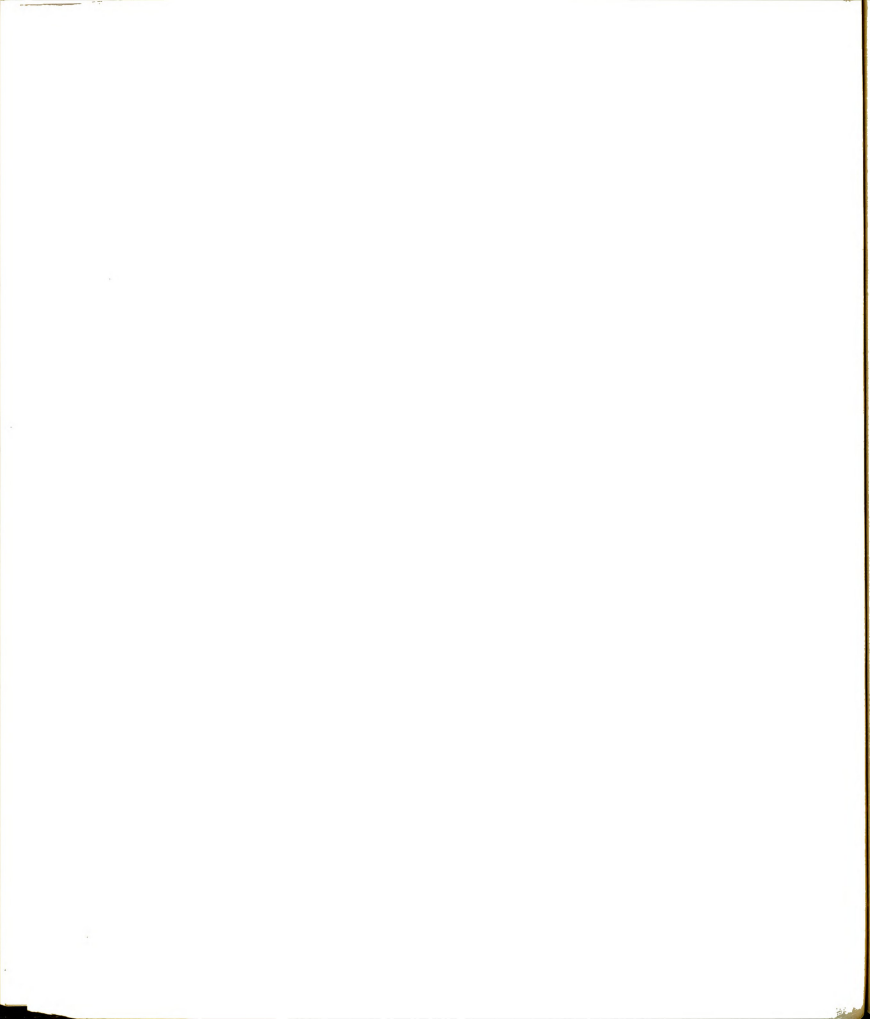
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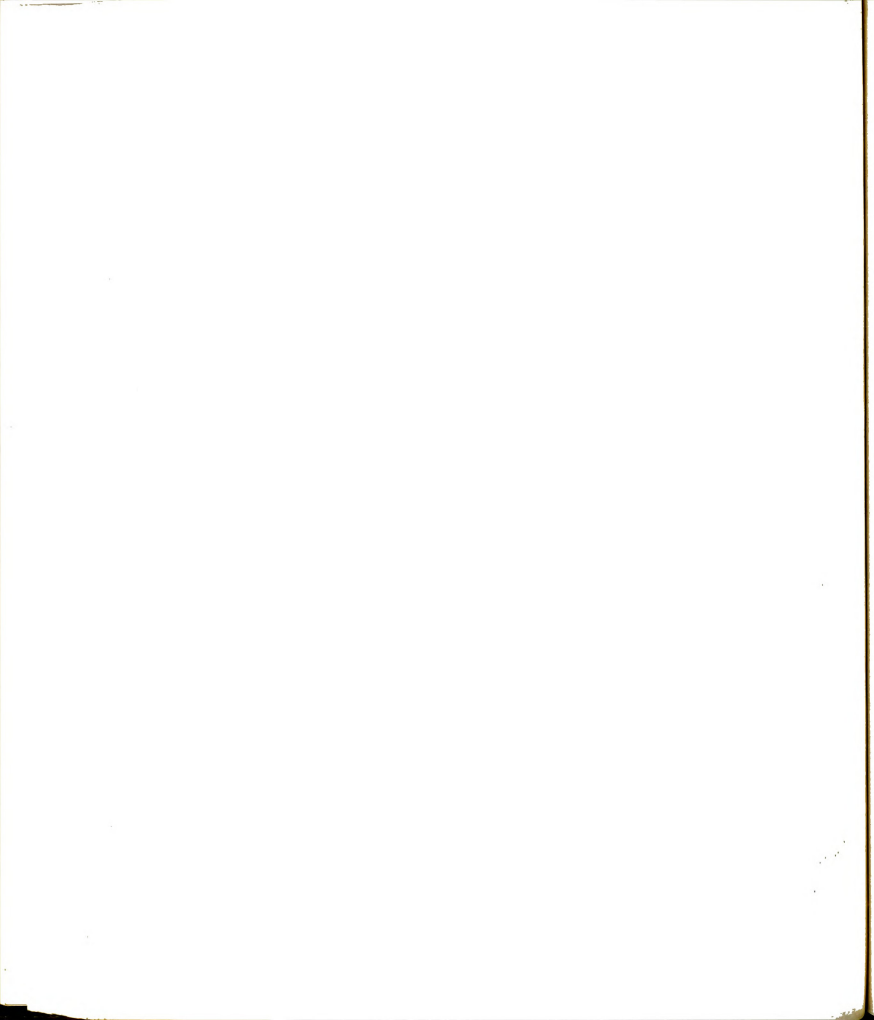
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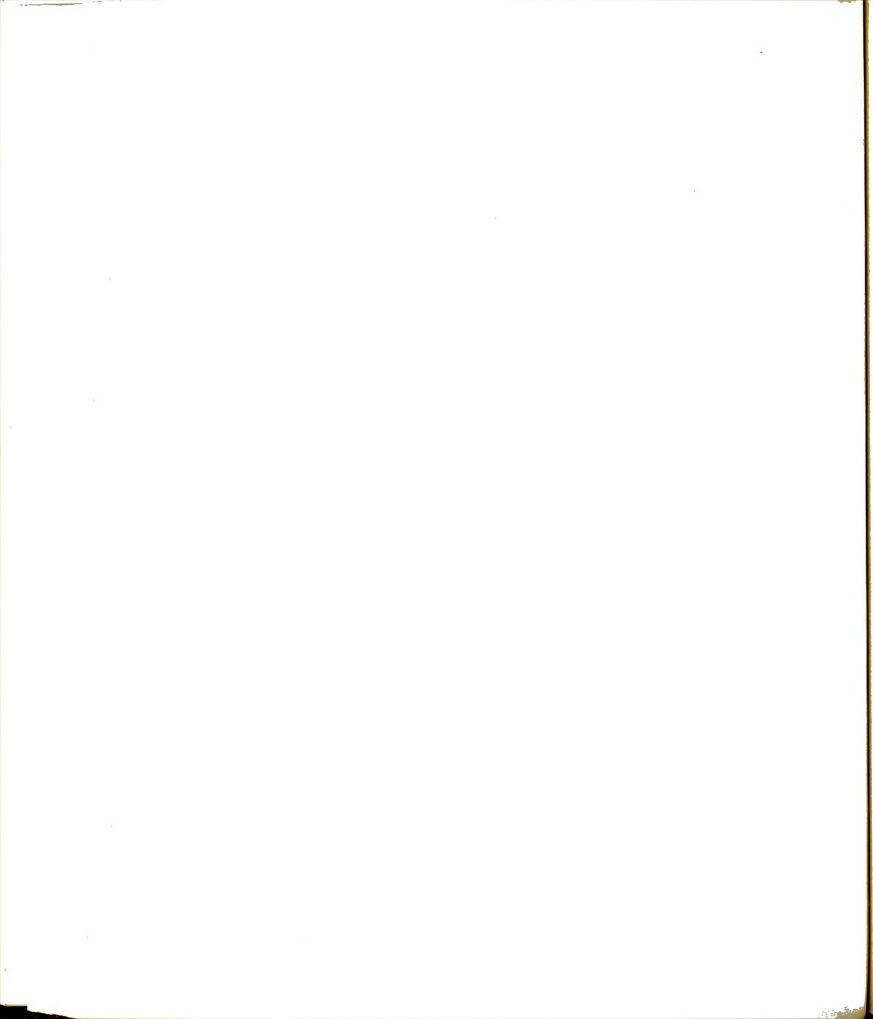
APPENDICES



APPENDIX A

BASIC TRACTOR OPERATORS' COURSE, GRADE I

1. Sequential Lesson Outline (3 pp.)
2. Instructor's Daily Training Program Schedule
(pp. 1-3 of 28 pp.)
3. List of Suggested Visual Aids
(pp. 1-5 of 12 pp.)



TRACTOR OPERATORS' TRAINING PROGRAM

BASIC COURSE - GRADE I

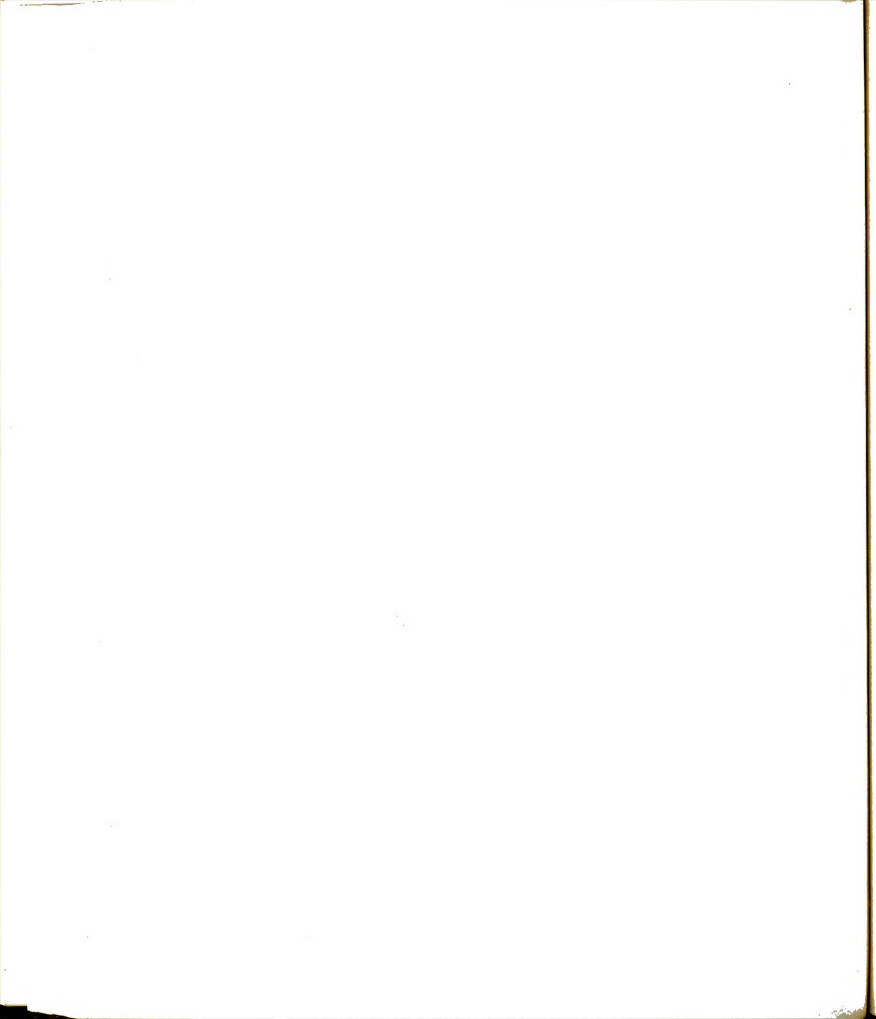
SEQUENTIAL LESSON OUTLINE

A. GETTING ACQUAINTED WITH THE TRACTOR

1. Orientation
2. Tractor Nomenclature
3. Principles of Engine Care
4. Internal Combustion Engines
5. Principles of Tractor Operation
6. Preliminary Driving
7. Power Transmission
8. Common Hand Tools

B. GETTING THE TRACTOR READY FOR WORK - PRESTARTING CHECKS

1. Need for Care and Maintenance
2. The 10-hour Daily (A) Maintenance Services
3. The Fuel System
4. Checking and Adding Fuel
5. Servicing the Sediment Bowls
6. The Air System
7. Servicing the Precleaner
8. Servicing the Oil Bath Air Cleaner
9. Servicing the Dry Filter Type Air Cleaner
10. The Engine Lubrication System
11. Servicing the Crankcase Oil
12. Greasing the Tractor
13. The Cooling System
14. Servicing the Cooling System
15. Checking the Tires and Wheels
16. The 50-hour (B) Maintenance Services



17. Servicing the Battery and Electrical System
18. Keeping Maintenance Records

C. STARTING AND WARMING THE ENGINE

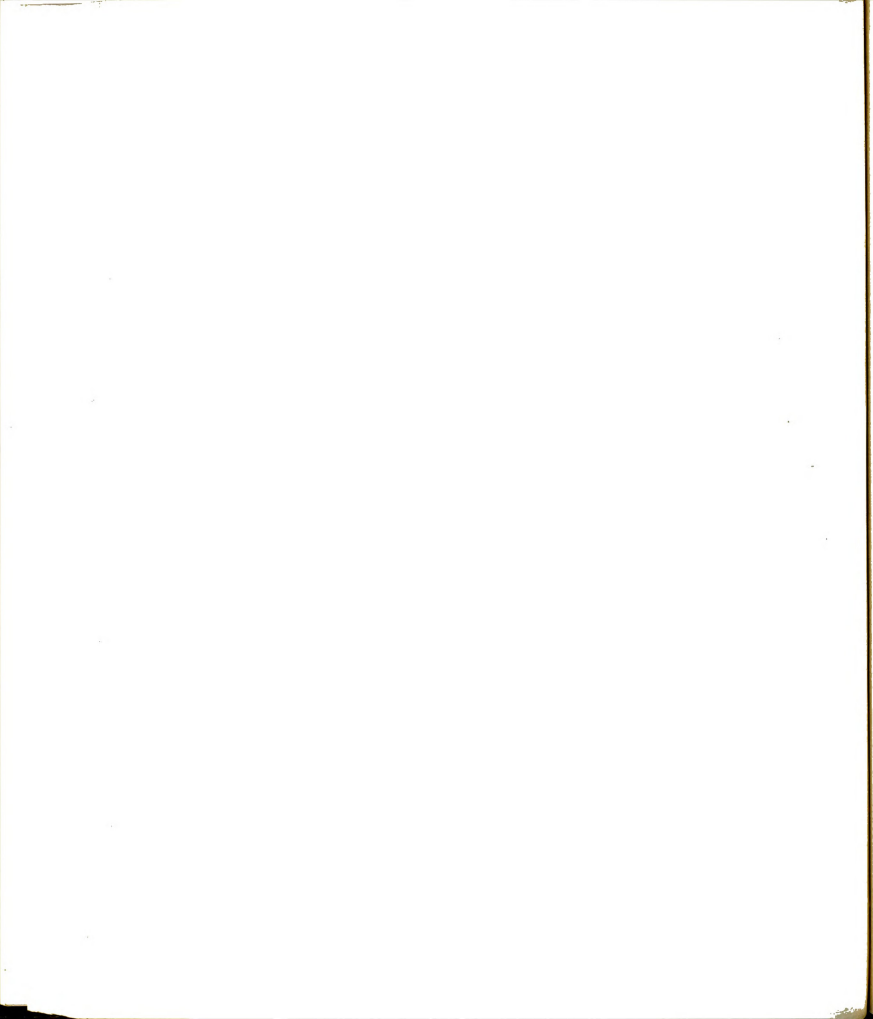
1. General Procedure and Safety
2. Mounting and Dismounting the Tractor
3. Adjusting the Seat
4. Setting Controls for Starting
5. Starting and Warming the Engine
6. Reading the Alternator Light
7. Reading the Oil Pressure Light
8. Reading the Water Temperature Gauge
9. Reading the Speed-hour Meter

D. OPERATING AND MANEUVERING THE TRACTOR

1. General Safety in Controlling the Tractor
2. Using the Hand and Foot Throttles
3. Using the Clutch
4. Selecting the Transmission Gear and Range
5. Using the Steering Wheel
6. Checking Gauges and Controls During Operation
7. Using the Brakes to Slow or Stop the Tractor
8. Using the Brakes to Assist in Steering a Slow Moving Tractor
9. Stopping the Engine and Parking the Tractor

E. MANAGING THE TRACTOR - USING GOOD JUDGMENT

1. Operating the Tractor Under Difficult Conditions
2. Matching Gears and Engine Speed and Avoiding Overload
3. Using the Differential Lock and Power Shift
4. Breaking in the New Tractor
5. Tractor Management and Records
6. Wheel Slip and Traction
7. Traffic Signs, Signal Lights, and Road Markings
8. Traffic Rules, Regulations, and Hand Signals



F. USING THE TRACTOR AS A POWER SOURCE

1. The Basic Power Systems and Power Safety
2. Adjusting and Hitching to the Drawbar
3. Using the 3-point Hitch Controls
4. Attaching and Detaching 3-point Hitch Implements
5. Hitching and Using the Double Acting Remote Hydraulic Cylinder
6. Pulling and Backing a Two-Wheeled Trailer or Implement
7. Pulling and Backing a Four-Wheeled Wagon or Trailer

G. SAFETY FACTORS

1. Selection and Safe Storage of Fuels and Lubricants
2. Guidelines for Human Safety
3. Guidelines for Tractor Safety

H. USING THE TRACTOR IN PRODUCTIVE FARMING OPERATIONS

1. Plowing With an Integral Disk Plow
2. Disking With an Integral Disk Harrow
3. Plowing With an Integral Moldboard Plow

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2

Basic Tractor Operators Course (Grade I)
(for low-education level trainees in developing
and developed countries)

INSTRUCTOR'S DAILY TRAINING PROGRAM SCHEDULE
(Three to Four Weeks)

KEY:	AD - Administration	AO - Actual object
	BR - Break	APM- All previous material
	CD - Conference demonstration	CH - Chart and graphs
	EV - Evaluation	FC - Flow chart
	FR - Field practical	IE - Individual Evaluation
	LP - Laboratory practical	MF - Movie Film
	RE - Review	SL - Slide and strip film
	TA - Aptitude test	SM - Simulated model
	TI - Pretest	TA - Trainee activities
	T2 - Post test	TF - Test form
		WS - Worksheet

First Week:

DAY 1						
Hour	Time Period	Instruction Method	Lesson Number	Main Subject	Visual Aid	Special Conditions
8:15	15	CD		Welcome by sponsors and school government officials		
	25	CD	A1	Orientation and purpose of course. Show slides or short film on tractor farming(furnished by Farm Machinery Mfgr)	SL MF	Orientation. Set stage for punctuality, positive attitude, enthusiasm
	5	BR		Break		
9	35	AD		Administration: Prepare trainee and course records. Obtain trainee data and information.	WS	Registration
	15	TI		Pretest A-1 for tractor operators.		Pretest of general knowledge.
	10	BR		Break		
10	40	TA		Aptitude of student skills and knowledge-may give simple non-verbal tests on mechanical and special aptitude, manual and finger dexterity.	TF	Compare aptitude of individuals under same conditions.
	15	TI		Pretest A-2 on trainee knowledge.	AO	Pretest on farm tractor.
	5	BR		Break		

Instructor's Daily Training Program Schedule

DAY 1 (continued)

Hour	Time Period	Instruction Method	Lesson Number	Main Subject	Visual Aid	Special Conditions
11	15	CD	A2	Tractor nomenclature, general	AO	Parts of diesel wheel tractor.
	40	LP		Identification and name of key parts.	CH	Large wall chart from tractor mgr.
	5	RE/EV		Review: evaluation and questions	APM IE	Small group evaluation. Individual evaluation.
12	60	AD		Lunch		
1	15	TL	A3	Pretest A-3 of trainees knowledge.	TF	Pretest on engine care.
	40	CD		Principles of engine care.	AO/SM	Instructor demonstrates need for engine care.
	5	BR		Break		
2	15	TL		Pretest A-4 on trainee knowledge.		Pretest on diesel engines
	15	CD	A4	The internal combustion engine.	SL	Show slides of 4 cycle engine. Demonstrate how engine works.
	20	LP		How an engine runs	WM	Use one-cylinder plastic model.
	10	BR		Break		
3	15	TL		Pretest A-5 on trainee knowledge.	TF	Pretest on tractor operation.
	20	CD	A5	Principles of tractor operation and use.	AO	Emphasize proper attitude.
	20	LP	A6	Preliminary tractor driving-use of selected controls.	AO	Instructor demonstrates tractor and shows trainees basic controls.
	5	BR		Break		
4	10	TL		Pretest A-6 on trainee knowledge.	TF	Pretest on driving the tractor.
	30	LP		Preliminary driving-simple maneuvering.	AO	Trainees drive on marked figure 8, course for familiarity.

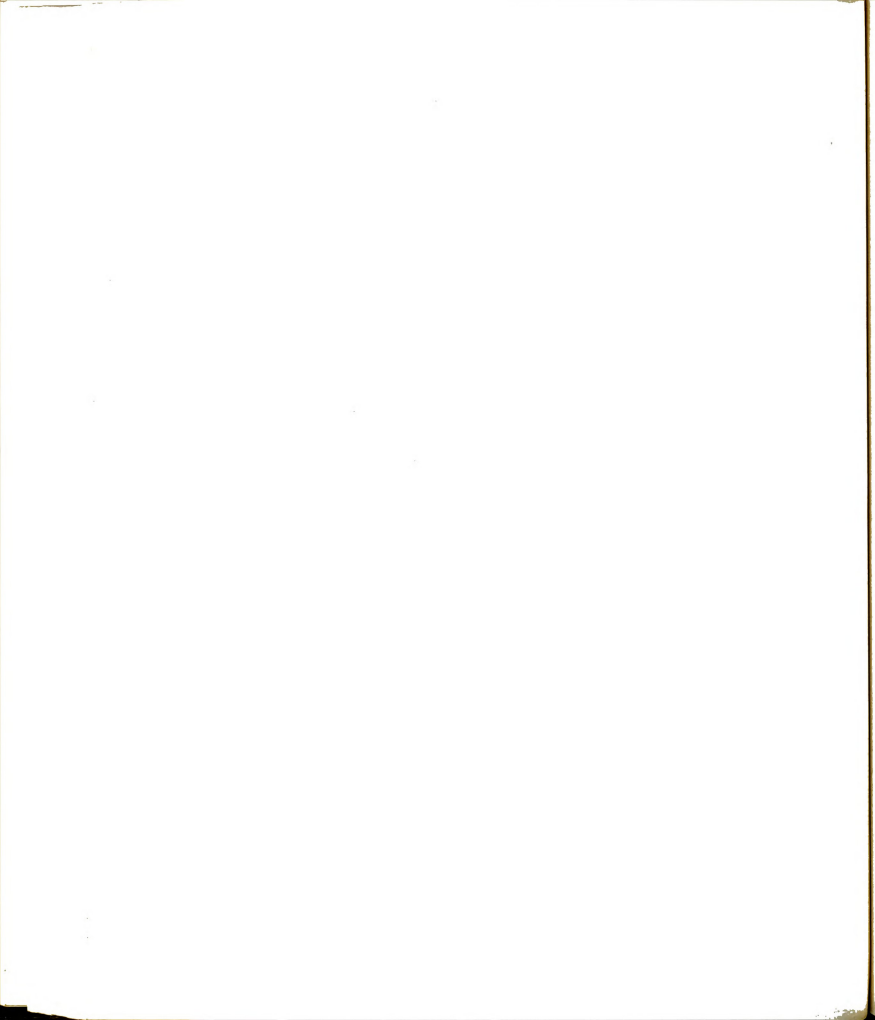
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Instructor's Daily Training Program Schedule

DAY 1 (continued)

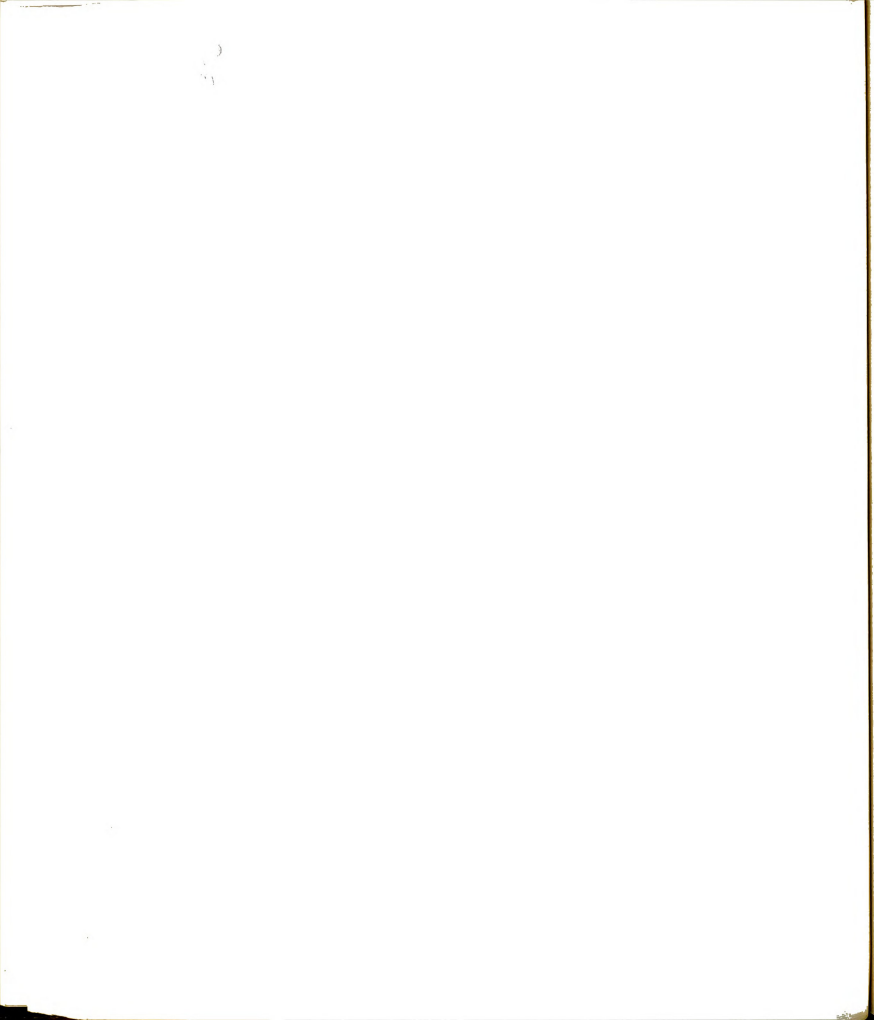
Hour	Time Period	Instruction Method	Lesson Number	Main Subject	Visual Aid	Special Conditions
	15	R&E		Review-daily evaluation and questions	IE	Trainees not driving can take some post tests.
	5	BR		Break		
5	20	T2		Post tests on day's work: Principles of operation. Tractor nomenclature and preliminary driving.	AO	The post tests may be given next day or even later in the middle of the week. Since the post tests are the same as the pretests, once the trainees have gotten accustomed to taking them, it should take not over 10 minutes per test.



LIST OF SUGGESTED VISUAL AIDS

1. Actual Objects: The best training aids are the actual objects themselves or parts thereof. The real thing is best in the final analysis because it is more vivid and being life size it has a greater impact upon the trainee. Nevertheless, charts, slides, films, illustrated books, models and a host of ingenious "home-made" training materials can help to get a point across and reinforce the learning experience. Some sources and types of teaching aids are listed under eight major headings: booklets and manuals, catalogs, charts, films models, references, result demonstrations and slides and filmstrips.
2. Booklets and Manuals
 - a) The Agricultural Tractor
 - 1) Operator's Manual, John Deere 1020/2020 (OM-T29489) John Deere Co., Moline, Ill (1969)
 - 2) Moteurs Diesel, Fonctionnement et Entretien, Ministere de L' Agriculture. Centre, National d'Etudes et d'Experimentation de Machinisme Agricole, 4th Edition, Antony, France (1967).
 - 3) Nebraska Tractor Test Data, 1970, University of Nebraska, Dept. of Agr. Engr., Lincoln, Nebraska 68503 (1970).
 - 4) Service Manual-For the Doctor of Motors, Perfect Circle, 6th Edition, Dana Corporation, Toledo, Ohio 43601 (1967).
 - 5) Farm Tractors, Engr. Bult. FT-535, Standard Oil Div., American Oil Co., Chicago, Ill., 60680 (1964).
 - 6) Tractor Maintenance: Bult #5 (2nd Ed) Industrial Field Mechanization and Labor Saving Committee, South African Sugar Assn, Durban, South Africa (1966).
 - b) Fuels and Lubricants
 - 1) Engine Protection Through Lube and Fuel Filtration, AC Spark Plug Div., General Motors Corp., Flint Michigan 48556.
 - 2) Selecting and Storing Tractor Fuels and Lubricants, American Assn. for Vocational Instructional Materials, Athens, Ga. 30601 (1964).
 - 3) Bearings and Their Lubrication, Engr. Bult. B-2265, Standard Oil Div., American Oil Co., 910 S. Michigan Avenue Chicago, Illinois (1962).
 - 4) Keep It Clean! No. 50316, C.A. V. Agricultural Dept., C.A. V., Ltd., Acton, London W. 3, England (1963).
 - 5) Thirty-Three Reasons for Oil Consumption, Form # 8040, Sealed Power Corp., International Div., Muskegon, Mich. 49443.
 - c) 4H Tractor Program, USA
 - 1) Tractor Care and Safety: Getting Acquainted with Your Tractor, 1st year (1963)
 - 2) Tractor Care and Safety: Assuring Safe Efficient Operation, 2nd yr (1964)
 - 3) Tractor Care and Safety: Improving your Skills, 3rd yr (1964)

- 4) Machinery Care and Safety: 4th and Advanced Years (1964)
 - 5) Operating Farm Tractors and Machinery-Efficiently and Safely, Iowa State Univ. of Science and Technology, Coop. Extension Service, Ames, Iowa.
- d) Internal Combustion Engines
- 1) Diesel the Modern Power, Public Relations Staff, General Motors, Detroit, Mich. 6th Edit, 48202 (1968)
 - 2) Power Goes to Work, Public Relations Staff, General Motors, Detroit, 48202 (1969).
 - 3) A Power Primer, Public Relations Staff, General Motors, Detroit 48202 (1969).
 - 4) The Story of Power, Public Relations Staff, General Motors, Detroit 48202 9th Printing (1969)
 - 5) A Tractor Log Book, Shell and BP Farm Service, East Africa, Nairobi, Kenya (1968).
 - 6) Tractor Tips - Champion Spark Plug Co., Toledo, Ohio (1969)
 - 7) Understanding and Measuring Horsepower: Motor, Engines, Tractors: American Association for Vocational Instructional Materials, Athens, Ga (1969).
 - 8) Borg Warner 1970 Tune-up Specifications; Cars, Trucks, Tractors; Manual 70-D, years 1961-70, Automotive Parts Div., Borg-Warner Corp., Franklin Park, Ill. 60131.
- e) Tools and Implements
- 1) ABC's of Hand Tools: Their Correct Usage and Care. General Motors Corp., Detroit, Mich. Reprinted (1967).
 - 2) Disk Plows, Farmers Bult #2121, USDA, U.S. Government Printing Office, Washington, D.C. 20402, Revised (1963).
 - 3) Moldboard Plows, Farmers Bult #2172, USDA, U.S. Government Printing Office, Washington, D.C. 20402, Revised (1961).
- f) Testing and Aptitude Measurement
- 1) Detroit Tests of Learning Aptitude, Examiner's Handbook, Bobbs-Merrill Co., Howard W. Sams & Co., Indianapolis, Indiana 46268, Revised (1967).
 - 2) Detroit Tests of Learning Aptitude; Pictorial Material for Tests 1,3,9,12,14,16 and 17. Bobbs-Merrill Co., Howard W. Sams Co., Indianapolis, Indiana 46268, Revised (1968).
 - 3) 4H Tractor and Machinery Programs: Guide for Extension Agents to Comply with U.S. Dept. of Labor Regulations on Hazardous Occupations in Agriculture, Coop. Extension Service. Michigan State University, East Lansing, Mich. 48823 (May, 1970).
 - 4) General Aptitude Test Battery, B-1002. Section I: Administration and Scoring, Manual for United States Employment Service, U.S. Dept. of Labor, Manpower Administration, Washington, D.C. 20210 (Jan. 1968).
 - 5) GATB: Book I, B-1002B (Separate-Answer Sheet Form), U.S. Employment Service, U.S. Dept. of Labor, Manpower Administration Washington, D.C. 20210 (May, 1970).
 - 6) GATB: Book II, B-1002B, (Separate-Answer Sheet Form) U.S. Employment Service, U.S. Dept. of Labor, Manpower Administration, Washington, D.C. 20210 (May 1970)
 - 7) Mechanical Aptitude and Spatial Relations Test -ARCO Editorial Board, ARCO, 219 Park Avenue S., N.Y., N.Y. 10003 (1966)



- 8) Testing Student Achievements and Aptitudes, by J. S. Ahmann, (1962) 118 pp.
- 9) What Every Driver Must Know, Public Information Office, Michigan Dept. of State, Lansing, Michigan (1969).

3. Catalogs

- a) Aids to Educators from General Motors, Public Relations Staff, General Motors, Detroit, Mich. 7th Edit. (1969).
- b) The 1970 School Catalog, Visual Products Div. 3-M Company, 3-M Center, St. Paul, Minn. 55101 (1970).
- c) Teaching aids, Publications, Filmstrips and Slides, American Association for Vocational Instructional Materials, Athens, Ga. 30601 (1969).
- d) Catalogo de Libros y Folletos en Espanol del RTAC - 1968 Centro Regional de Ayuda Technica, Agencia Para El Desarrollo International (A.I.D.)-Mexico (1968).

4. Charts

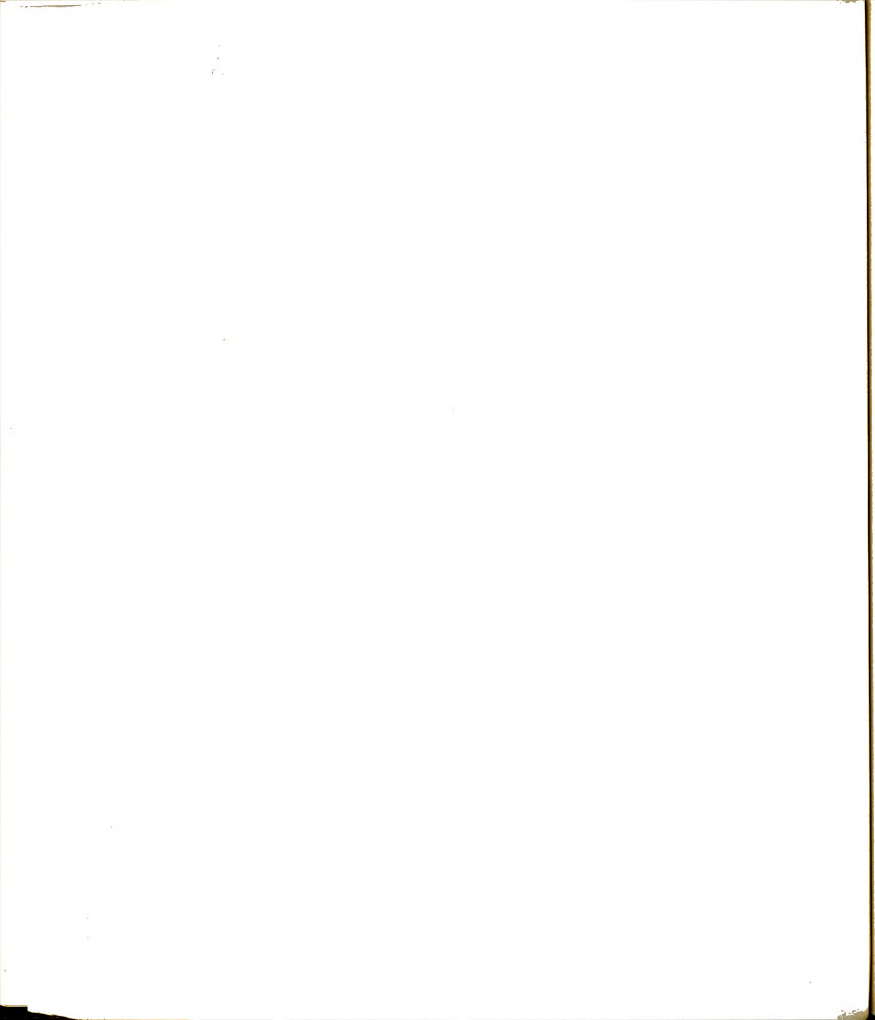
- a) Diesel-Cycle Diagram, Public Relations Staff, General Motors Corp., Detroit, Mich 48202, 22' x 30"
- b) Four-Stroke Cycle and Flame Travel, Public Relations Staff, General Motors, Detroit, Michigan 48202
- c) Typical Gear Combinations. Public Relations Staff, General Motors, Detroit, Mich 48202.
- d) Rear axel assembly, Public Relations Staff, General Motors, Detroit, Michigan 48202.
- e) Set-ups for Upsets--Operate Safely! National Safety Council, Chicago, Ill. (F3905-B, 1969) 17" x 23"

5. Films, Movie

- a) Educational Films, Joint UM-MSU Film Catalog, East Lansing, Mich. (1969) pp 568.
- b) GM Films, 1970, General Motors Motion Picture Catalog. 29th Edition, Public Relations Staff, Film Library, GM Building, Detroit, Michigan 48202.
- c) Films of the U.S. Dept. of Agriculture, Agric. Handbook, No. 14, 1968, Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20241.

6. Models

- a) Realistic Metal Scale Model Tractors, Ertl Co., Dyersville, IOWA
- b) Plastic Model 6-cylinder Engine with Moving Parts, Revel Mfrg. Co.
- c) Four-cycle Engine, Working Piston, Plastic Device, 3M Visual Products Div., St. Paul, Minn. 55101 (1969).
- d) Two-cycle Engine, Working Piston, Plastic Device, 3M Visual Products Div., St. Paul, Minn. 55101 (1969).



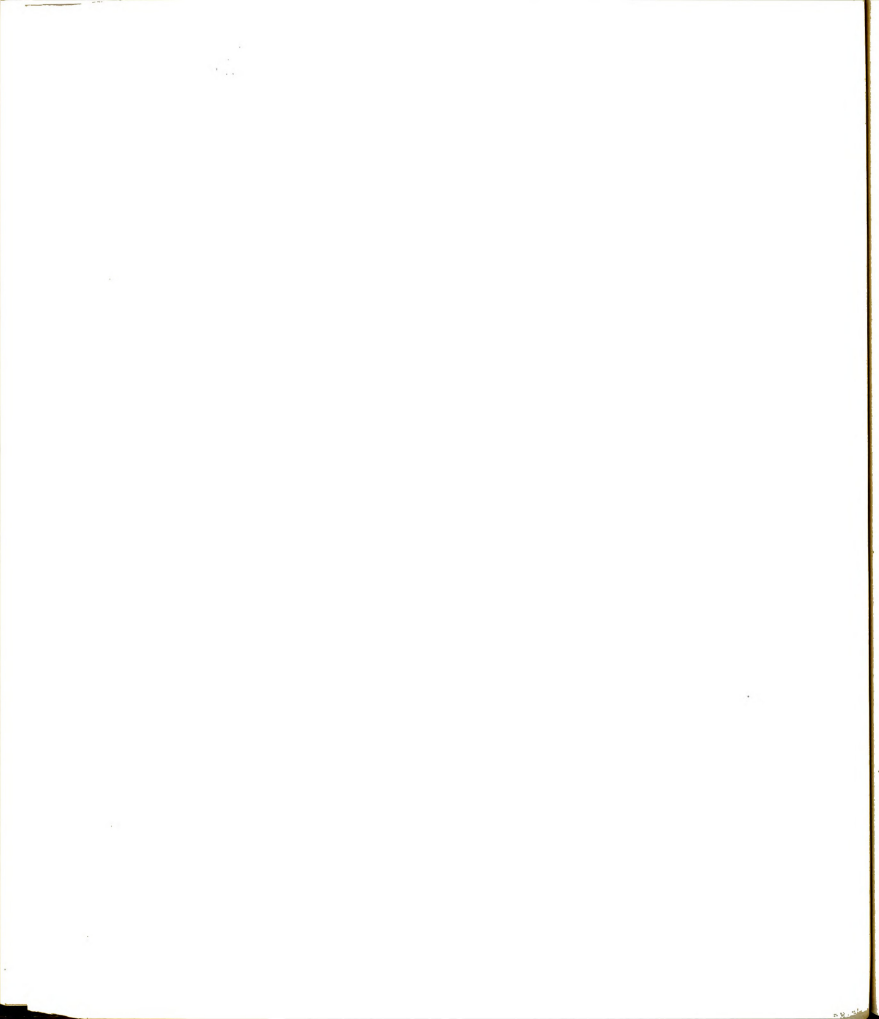
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- 1) Agricultural Engineering Training and Education in Africa, by Boshoff, W.H. and G.G. Corbett, FAO Report, Rome, Italy (1965)
- 2) Agricultural Engineering Education in Developing Countries, by E. F. Olver, Agr. Engr. Dept., Univ. of Illinois, (May 1970).
- 3) Assessing and Reporting Training Needs and Progress-Personnel Methods Series No. 3, U.S. Civil Service Commission, Washington D.C. (Revised 1961).
- 4) Audio-Visual Instruction, by R.E. de Kieffer, (1965) 117 pp.
- 5) The ABC's of the Critical Path Method, Levy, Thompson and West, Reprint from "Harvard Business Review", (Sept.-Oct. 1963).
- 6) Relating Principles of Learning to Instructional Activity, Proceedings of Symposium on Instruction, North Central Region Resident Instruction, Colleges of Agriculture, Univ. of Illinois (June, 1967).
- 7) Education and Training for the World of Work: A Vocational Education Program for the State of Michigan, by H.T. Smith, The W. E. Upjohn Institute for Employment Research, 300 S. Westnidge Ave., Kalamazoo, Mich. 49007 (1963).
- 8) Education and Agricultural Development-Freedom from Hunger Campaign, Basic Study #15, UNESCO, Paris, France (1964).
- 9) Guide for Village Workers-Extension Methods by Ministry of Food and Agriculture, India (1955), USDA, Wash. D.C. (Reprint 1967) 55 pp.
- 10) Preparing Instructional Objectives, R. F. Mager, Fearon Publishers, Palo Alto, Calif (1962).
- 11) Schooling for Individual Excellence. D.H. Parker, Thomas Nelson and Sons, N.Y., N.Y. (1965).
- 12) Training Manual: for Group Study of Getting Agriculture Moving, by A.T. Mosher, Editor, Agricultural Development Council, Inc., 630 5th Ave., N.Y., N.Y., 10020 (1967).
- 13) Where to Get and How to Use Free and Inexpensive Teaching Aids, by Schain and Polner (1963).

b. U. S. Army Publications on Training

- 1) Controlling the Quality of Training, by R.G. Smith, Jr. Technical Report 65-6, Research and Development, Dept. of Army, Ft. Belvoir, Va. (1965).
- 2) The Demonstration Method, Lesson Reference File, IG. 005-2, U.S. Army Engineer School, Ft. Belvoir, Va. (1968).
- 3) Development of Instructors, I.G. 030-2, US Army Engr. School, Ft. Belvoir, Va. (1967).
- 4) Diagnostic Procedures (Diesel Engine) M.006-8, M.206-7, US Army Engineer School, Ft. Belvoir, Va. (1970).
- 5) Development of Supervisors, IG.030-1, US Army Engineer School, Ft. Belvoir, Va. (1968).
- 6) Instructors Manual, Instructor Training Course, US Army Engineer School, Ft. Belvoir, Va. (1968).
- 7) Student Manual, Instructor Training, US Army Engineer School, Ft. Belvoir, Va. (1968)?).



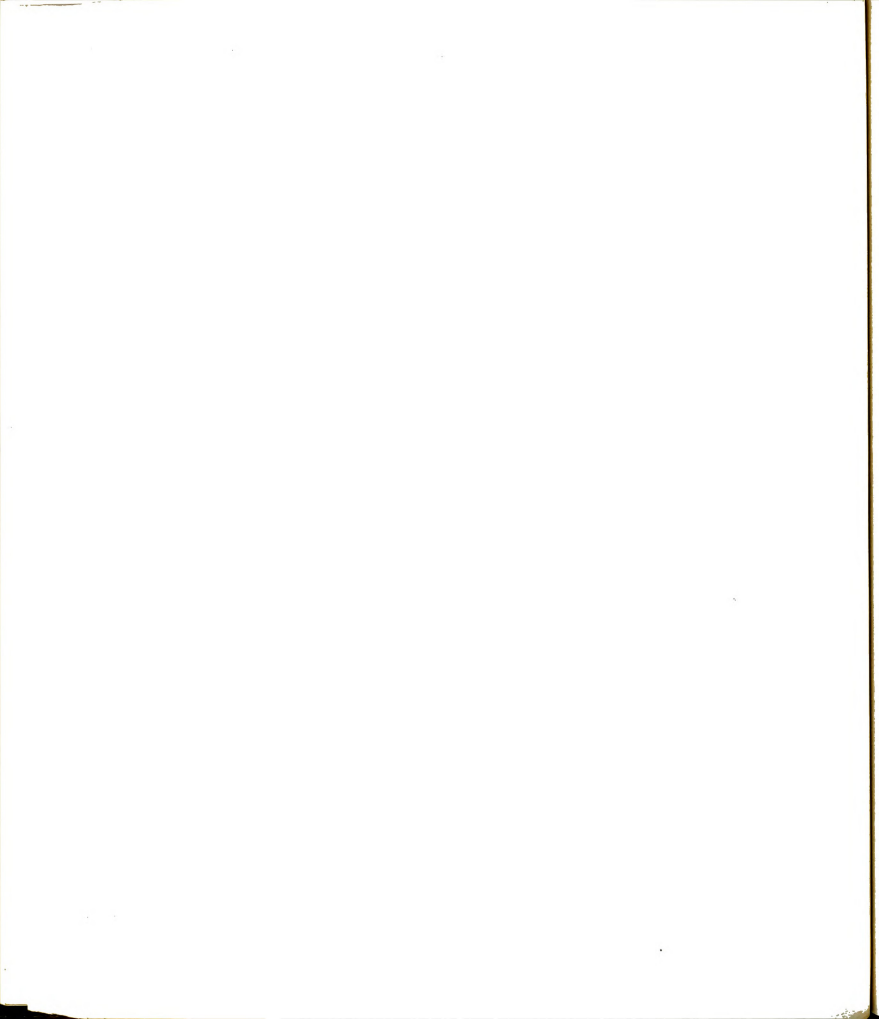
- 8) Introduction to Diesel Engines, M.006-1, M.206-1, US Army Engineer School, Ft. Belvoir, Va. (1969).
- 9) Methods of Evaluation, IG.006-1, US Army Engineer School, Ft. Belvoir, Va. (1968).
- 10) Operator Selection and Training, T210-510, US Army Engineer School, Ft. Belvoir, Va. (1968).
- 11) Principles and Types of Aids, IG.004-1, US Army Engineer School, Ft. Belvoir, Va. (1968).
- 12) Preparation of an Instructors Lesson Plan, IG. 003-1, U.S. Army Engineer School, Ft. Belvoir, Va. (1967).
- 13) Psychology of Learning, IG.002-1, US Army Engineer School, Ft. Belvoir, Va. (1966).
- 14) Training Conference Method, IG. 005-1, US Army Engineer School, Ft. Belvoir, Va. (1967).
- 15) Ungraded and Graded Practical Exercises, IG. 006-3, US Army, Engineer School, Ft. Belvoir, Va. (1968).

8. Result Demonstrations

- a) American Premier Diesel Fuel: Demonstration Kit on the Additive Story, The American Oil Co., Chicago, Illinois (1961).
- b) Demonstration Manual on Farm Tractor Safety: For Use by Agricultural Leaders When Demonstrating with the Farm Safety Kit, Farm Division, National Safety Council, Chicago, Ill.
- c) Seeing is Believing. Strow and Cowing, USDA, Washington. D.C. 1960), 12pp.

9. Slides and Filmstrips

- a) Color Filmstrips and Slide Sets of the USDA, Miscell. Publication No. 1107, Supt'd of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (1968).
- b) Suggested Slides from John Deere for use in a Basic Tractor Operators Course (See our book and list available slides here)
 - 1) Lesson A-1: Orientation
 - a. Happy Tractor and Operator (JD:cartoon)
 - 2) Lesson A-2: Tractor Nomenclature
 - b. Close-up view of Drivers Platform (JD:T 15338)
 - 3) Lesson A-3: Principles of Engine Care
 - a. Happy Tractor and Operator (See slide "a", Lesson A-1)
 - c. Engine is the Heart of the Tractor (JD OPTD: L,10-DEF)
 - d. Air Needed for Combustion (JD: FOS-30 #6)
 - e. Cutaway View of Diesel Tractor (JD:L, 9-DEF)
 - 4) Lesson A-4: Internal Combustion Engines
 - f. Diesel Fuel System (JD: FOS-30 #13)
 - g. Intake and Exhaust Systems (JD: FOS-30 #14)
 - h. Cooling System (JD:FOS-30#16)
 - i. Lubrication System (JD:FOS-30 #15)
 - j. Summary Power Trains (JD:FOS-30#30)



APPENDIX B

SAMPLE PAGES OF SEVERAL CURRENT APTITUDE TESTS

1. Detroit Mechanical Aptitudes Examination, Form A
(pp. 2 of 8)
2. Purdue Mechanical Adaptability Test, Form A Men
(pp. 2 of 4)
3. Revised Minnesota Paper Form Board Test, Series AA
(pp. 2 of 6)
4. U.S. Employment Service GATB, Book II, Form B
(pp. 2 of 19)
5. Differential Aptitude Tests, Mechanical Reasoning,
Form A (pp. 2 of 19)
6. Nine Aptitudes Measured by the GATB
7. Definitions of Aptitudes Measured by the GATB



Printed in U. S. A.

DETROIT MECHANICAL APTITUDES EXAMINATION, FORM A

Name..... First..... Last..... Years..... Months.....

Address..... School..... Date.....

Occupation (1)..... (2).....

Number of Tools in Home.....

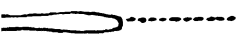
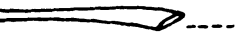
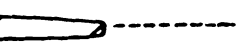
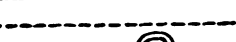
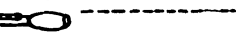
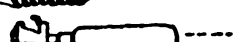
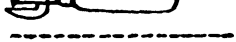
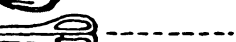
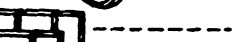
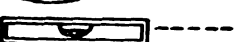
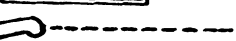
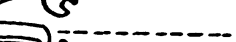
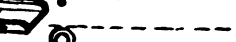
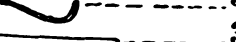
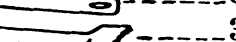
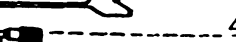
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to the Detroit Board of Education.

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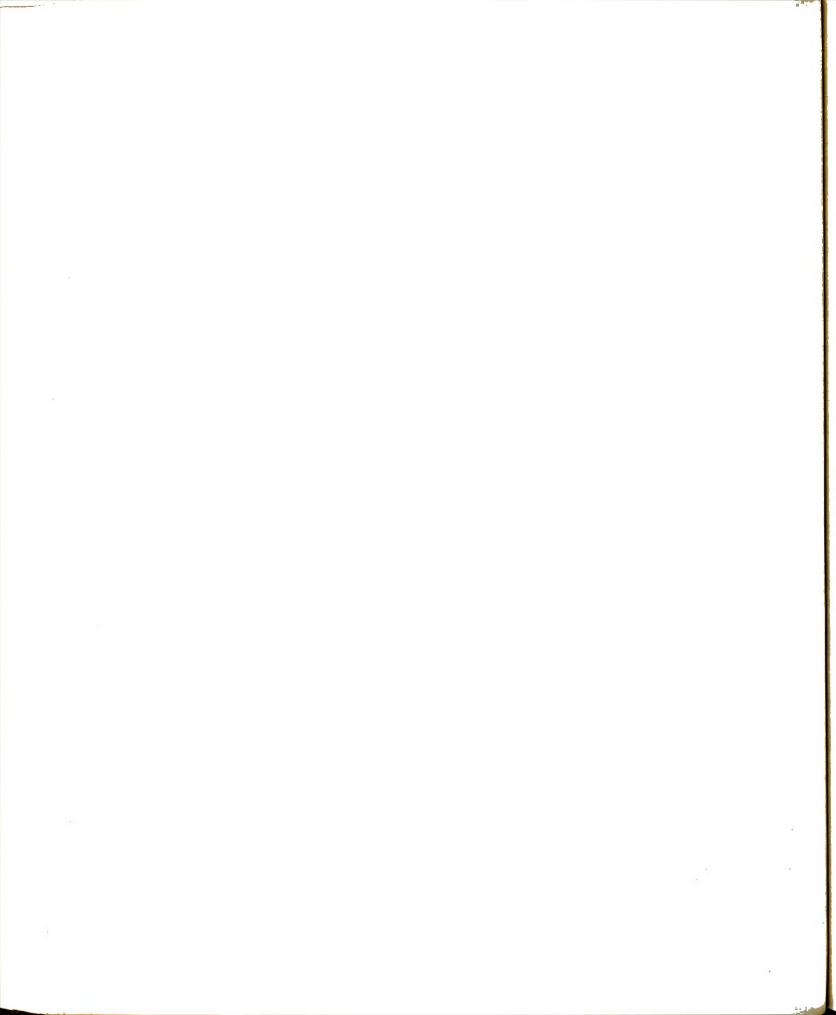
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v	129	f	130	d	131	c	132	m	133	r	134	y	135	k	136
m	121	r	122	c	123	v	124	k	125	f	126	d	127	l	128
v	113	y	114	m	115	f	116	d	117	c	118	k	119	f	120
y	105	d	106	f	107	k	108	r	109	m	110	v	111	l	112
f	97	k	98	m	99	c	100	l	101	v	102	d	103	l	104
v	89	m	90	c	91	d	92	f	93	y	k	r	95	l	96
c	81	d	82	k	83	m	84	r	85	v	86	y	87	l	88
k	73	r	74	v	75	f	76	d	77	m	78	c	79	l	80
d	65	y	66	k	67	v	68	f	69	l	70	m	71	c	72
c	57	k	58	r	59	y	60	d	61	v	62	m	63	l	64
r	49	d	50	m	51	f	52	c	53	v	54	k	55	l	56
y	41	v	42	c	43	m	44	d	45	f	46	r	47	l	48
m	33	v	34	k	35	f	36	c	37	y	38	d	39	l	40
f	25	d	26	y	27	r	28	m	29	v	30	k	31	c	32
l	17	l	18	m	19	y	20	c	21	d	22	l	23	y	24
f	9	l	10	d	11	y	12	v	13	f	14	c	15	l	16
k	1	y	2	d	3	f	4	m	5	v	6	r	7	l	8
r	1	k	2	v	3	f	4	m	5	c	6	d	7	l	8
l	9	l	10	l	11	l	12	l	13	l	14	l	15	l	16
l	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15



	A	1 chisel	2 shovel	3 hammer	4 saw	(
	B	1 pliers	2 screw driver	3 pencil	4 file	(
	1	1 shovel	2 saw	3 axe	4 level	(
	2	1 wrench	2 file	3 pencil	4 scythe	(
	3	1 bell	2 thread	3 hat	4 thimble	(
	4	1 clippers	2 knife	3 shears	4 pliers	(
	5	1 light bulb	2 oil can	3 countersink	4 syringe	(
	6	1 shears	2 tin snips	3 pliers	4 clippers	(
	7	1 wrench	2 hammer	3 wood clamp	4 monkey wrench	(
	8	1 needle	2 spoon	3 nail punch	4 glass cutter	(
	9	1 teapot	2 freezer	3 double boiler	4 skillet	(
	10	1 soldering iron	2 masher	3 nail punch	4 bit	(
	11	1 trowel	2 shovel	3 dibble	4 butter knife	(
	12	1 bit	2 nail	3 countersink	4 screw	(
	13	1 corkscrew	2 can opener	3 crochet hook	4 glass cutter	()
	14	1 water	2 faucet	3 awl	4 hose	()
	15	1 pickle fork	2 salad fork	3 dividers	4 can opener	()
	16	1 shears	2 tin snips	3 pliers	4 clippers	()
	17	1 freezer	2 emery wheel	3 potato ricer	4 egg beater	()
	18	1 knife	2 outside calipers	3 micrometer	4 dividers	()
	19	1 awl	2 nail punch	3 glass cutter	4 hand drill	()
	20	1 masher	2 wrench	3 gravy ladle	4 trowel	()
	21	1 slaw cutter	2 tool box	3 dividers	4 miter box	()
	22	1 switch	2 electric plug	3 current	4 bulb	()
	23	1 potato ricer	2 nut cracker	3 wood clamp	4 sieve	()
	24	1 steam gauge	2 micrometer	3 level	4 knife	()
	25	1 butter knife	2 draw knife	3 mallet	4 cleaver	()
	26	1 hack saw	2 back saw	3 coping saw	4 keyhole saw	()
	27	1 "S" wrench	3 monkey wrench	3 angle wrench	4 alligator wrench	()
	28	1 micrometer	2 calipers	3 iron clamp	4 vise	()
	29	1 nail set	2 awl	3 screw driver	4 auger	()
	30	1 washing board	2 level	3 plane	4 slaw cutter	()
	31	1 buttonhole scissors	2 tin snips	3 clamps	4 dividers	()
	32	1 pencil holder	2 emery wheel	3 egg beater	4 hand drill	()
	33	1 dividers	2 micrometer	3 outside calipers	4 inside calipers	()
	34	1 wrench	2 hand drill	3 screw driver	4 egg beater	()
	35	1 stocking darning	2 mallet	3 dowel	4 wood clamp	()
	36	1 plane	2 glass cutter	3 putty knife	4 draw knife	()
	37	1 inside calipers	2 outside calipers	3 dividers	4 compass	()
	38	1 "S" wrench	2 monkey wrench	3 end wrench	4 micrometer	()
	39	1 alligator wrench	2 angle wrench	3 "S" wrench	4 pipe wrench	()
	40	1 clamp	2 vise	3 micrometer	4 wrench	()

No. Right =



Name _____ Date _____
 Last First Month Day Year

SAMPLE TEST FILE

Form

A

Men

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PURDUE PERSONNEL TESTS

PURDUE
 MECHANICAL ADAPTABILITY TEST

by

C. H. Lawshe, Jr., and Joseph Tiffin
 Division of Applied Psychology, Purdue University

DIRECTIONS

The questions in this test deal with simple information of a mechanical, electrical, or related nature. Certain jobs can be done better by people who know the answers to these questions. Many other jobs, however, can be done just as well by persons who do not know the answers.

Here is a sample question.

1a. Is an emery wheel used in sharpening tools?

Don't		
Yes	No	Know
☐	☐	☐

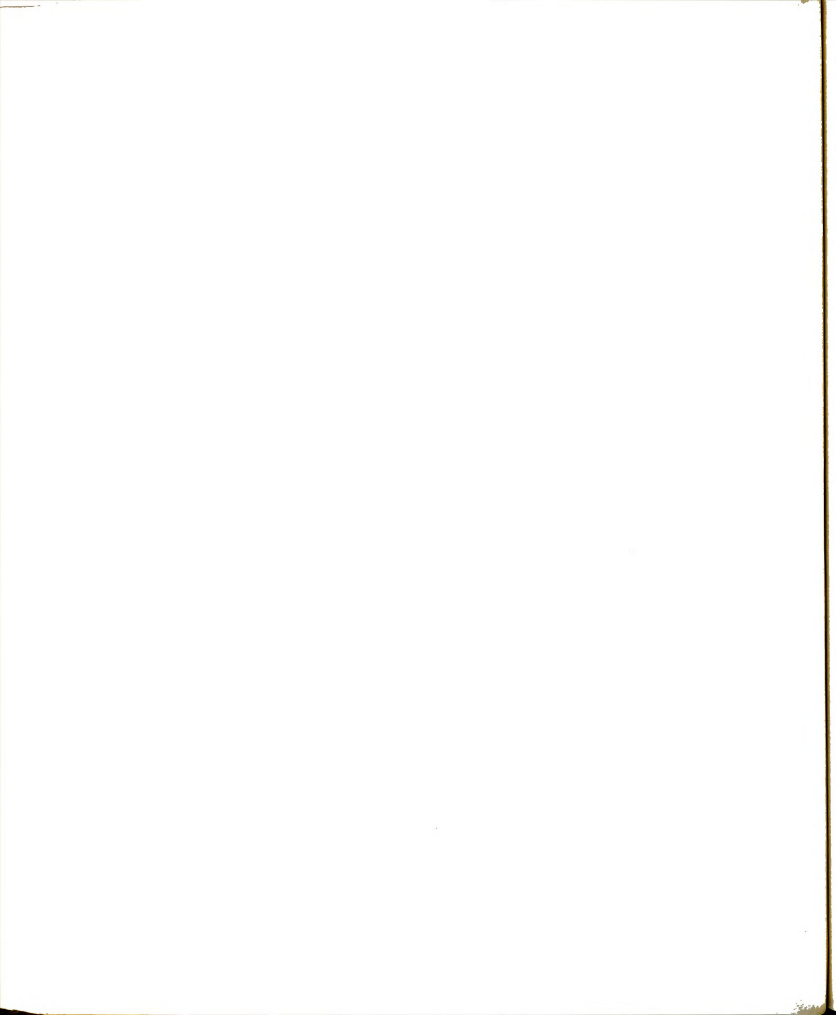
Note that there are three squares after the question. If you believe the answer is "yes", place an "X" in the square under the word "YES"; if you believe the answer is "no", place an "X" in the square under the word "NO". If you do not know the answer, place your "X" in the square under "DON'T KNOW".

You are to make one "X", and only one "X", after each question.

You will not know the answers to all the questions, but do the best you can. It will not pay you to spend a great deal of time on any one question. You have fifteen minutes which is plenty of time if you do not spend too much time on questions you do not know.

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Form A

Yes No Don't Know

- | | Yes | No | Don't Know |
|--|--------------------------|-------------------------------------|-------------------------------------|
| 31. Will ordinary solder repair aluminum kitchen ware?..... | ☐ | ☐ | ☐ |
| 32. Is re-capping the same as re-treading?..... | ☐ | ☒ | ☐ |
| 33. Are manifold gaskets and oil pan gaskets usually made of the same material?..... | ☐ | ☒ | ☐ |
| 34. When a crossed belt connects two pulleys, will they revolve in the same direction? | ☐ | ☐ | ☐ |
| 35. Does paint dry faster than japan lacquer?..... | ☐ | ☐ | ☐ |
| 36. Is it possible to step-up or step-down household voltage?..... | ☐ | ☐ | ☐ |
| 37. Are reaming operations a part of drill-press work?..... | ☐ | ☐ | ☐ |
| 38. Can a dry cell battery be temporarily revived by heating slightly?..... | ☐ | ☐ | ☐ |
| 39. Is it necessary to take a finishing cut when turning soft wood?..... | ☐ | ☐ | ☐ |
| 40. Is a hydrometer used to test an automobile battery?..... | ☐ | ☐ | ☐ |
| 41. Is oil placed in the crank case of an automobile to protect the differential?..... | ☐ | ☐ | ☐ |
| 42. Do any of the tubes in a radio have two prongs at the bottom?..... | ☐ | ☐ | ☐ |
| 43. Can sand be used to clean spark plugs?..... | ☐ | ☐ | ☐ |
| 44. Should the waste pipe of plumbing fixtures be vented?..... | ☐ | ☐ | ☐ |
| 45. Does an automobile stop light operate through a transformer?..... | ☐ | ☐ | ☐ |
| 46. Does a radio tuning-coil wind up and unwind as the radio tuning knob is turned back and forth?..... | ☐ | ☐ | ☐ |
| 47. Is an ordinary ball peen hammer the best hammer with which to pound out fender dents? | ☐ | ☐ | ☐ |
| 48. Can Sal Amoniac be used to clean a soldering iron?..... | ☐ | ☐ | ☐ |
| 49. Should the grounded terminal on an automobile battery be insulated?..... | ☐ | ☐ | ☐ |
| 50. Is a mitre box used by a cabinet maker?..... | ☐ | ☐ | ☐ |
| 51. Are most automobile batteries 6-volt batteries?..... | ☐ | ☐ | ☐ |
| 52. Will aluminum paint cover more surface than the better grades of white lead?..... | ☐ | ☐ | ☒ |
| 53. Are the wires in an electric iron reversible?..... | ☐ | ☐ | ☐ |
| 54. Is gloss paint used to prime wood which is to receive several coats?..... | ☐ | ☐ | ☐ |
| 55. When using an oil-finish on wood, is boiled linseed oil more satisfactory than raw linseed oil?..... | ☐ | ☐ | ☐ |
| 56. Do car generator bearings become corroded with use?..... | ☐ | ☐ | ☐ |
| 57. Is BX the same as rigid iron conduit?..... | ☐ | ☐ | ☐ |
| 58. Do bell transformers ordinarily deliver approximately 50 volts?..... | ☐ | ☐ | ☐ |
| 59. In a valve-in-block engine, are valve springs below the valve heads?..... | ☐ | ☐ | ☐ |
| 60. Is nitric acid used in storage batteries?..... | ☐ | ☐ | ☐ |

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DIRECTIONS AND PRACTICE PROBLEMS

20

READ THE FOLLOWING DIRECTIONS VERY CAREFULLY WHILE THE EXAMINER READS THEM ALOUD

Look at the problems on the right side of this page. You will notice that there are eight of them, numbered from 1 to 8. Notice that the problems go DOWN the page.

First look at Problem 1. There are two parts in the upper left-hand corner. Now look at the five figures labelled A, B, C, D, E. You are to decide which figure shows how these parts can fit together. Let us first look at Figure A. You will notice that Figure A does not look like the parts in the upper left-hand corner would look when fitted together. Neither do Figures B, C, or D. Figure E does look like the parts in the upper left-hand corner would look when fitted together, so E is PRINTED in the square above [1] at the top of the page.

Now look at Problem 2. Decide which figure is the correct answer. As you will notice, Figure A is the correct answer, so A is printed in the square above [2] at the top of the page.

The answer to Problem 3 is B, so B is printed in the square above [3] at the top of the page.

Problem 4, D is the correct answer, so D is printed in the square above [4] at the top of the page.

Now do Problems 5, 6, 7, and 8.

PRINT the letter of the correct answer in the square above the number of the example at the top of the page.

DO THESE PROBLEMS NOW.

If your answers are not the same as those which the examiner reads to you, RAISE YOUR HAND.

DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Some of the problems on the inside of this booklet are more difficult than those which you have already done, but the idea is exactly the same. In each problem you are to decide which figure shows the parts correctly fitted together. Sometimes the parts have to be turned around, and sometimes they have to be turned over in order to make them fit. In the square above [1] write the correct answer to Problem 1; in the square above [2] write the correct answer to Problem 2, and so on through the rest of the test. Start with Problem 1, and go DOWN the page. After you have finished the column, go right on with the next. Be careful not to go so fast that you make mistakes. Do not spend too much time on any one problem.

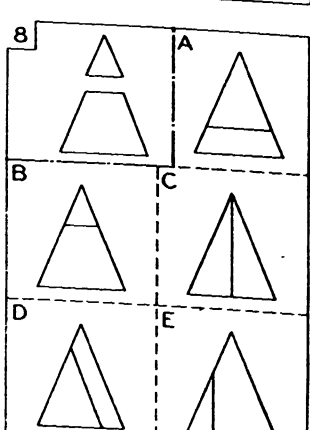
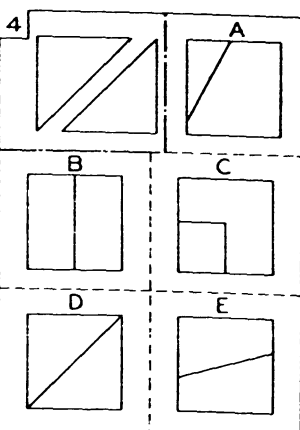
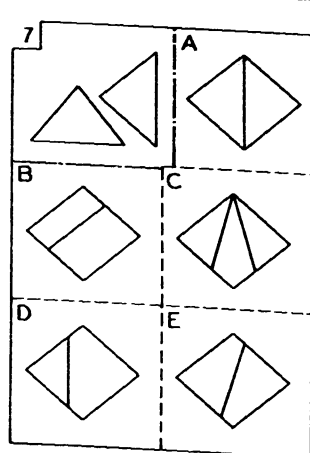
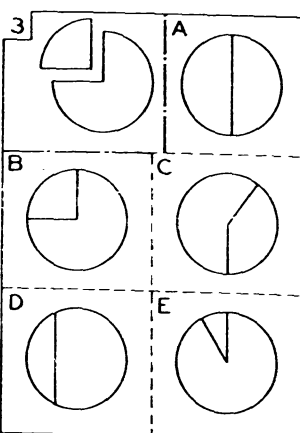
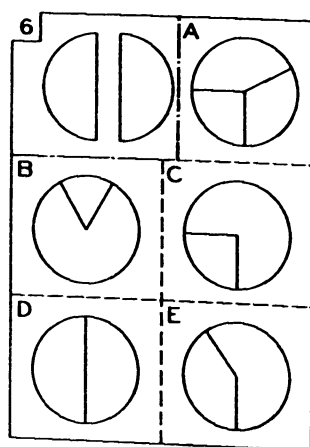
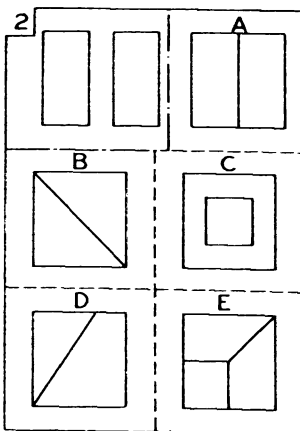
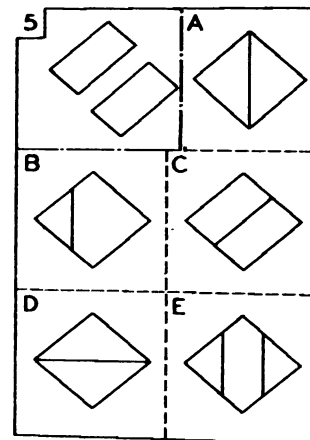
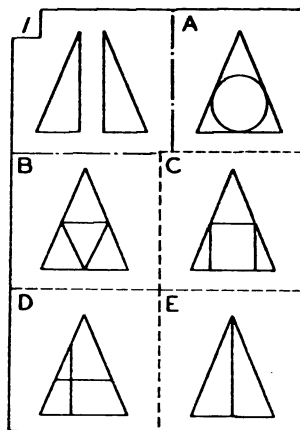
WRITE WITH CAPITAL LETTERS ONLY.

KEEP THEM SO THAT ANYONE CAN READ THEM.

DO NOT OPEN THE BOOKLET BEFORE YOU ARE TOLD TO DO SO.

YOU WILL HAVE EXACTLY 20 MINUTES TO THE WHOLE TEST.

E	A	B	D	C	D	A	13
1	2	3	4	5	6	7	8



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Page

Score	Percentile	Norms Used
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REVISED MINNESOTA PAPER FORM BOARD TEST

Prepared by R. Likert and Wm. H. Quasha

Fill in the blanks below (name, age, etc.)

BUT DO NOT TURN OVER OR OPEN THE BOOKLET UNTIL THE SIGNAL IS GIVEN

PRINT WITH CAPITAL LETTERS

ne
(Last) (First) (Middle)

School or Institution.....

ay's Date (Month) (Day) (Year)

Inspector's or Foreman's Name.....

Last Birthday **Sex**

Place of Birth.....
(Month) (Day) (Year in which you were born)

le I Am Now In: Grammar School 1 2 3 4 5 6 7 8 High School 1 2 3 4 College 1 2 3 4 5 6 7
(Put a circle around the grade you are now in)

Department

DO NOT TURN OVER OR OPEN THE BOOKLET UNTIL THE SIGNAL IS GIVEN

rtis in most of the problems are taken from the Minnesota Paper Form Board Tests which appear in Paterson, Donald G.; Elliott, Richard M.; n, L. Dewey; Toops, Herbert A.; and Heidbreder, Edna. "Minnesota Mechanical Ability Tests," University of Minnesota Press, pages 94-101. Used mission.

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B-1002B

Reprinted 5/1/70

FORM B

CONTROLLED ITEM

UNITED STATES EMPLOYMENT SERVICE

GATB

BOOK II

(Separate-Answer-Sheet Form)

GENERAL DIRECTIONS

This booklet has several different parts. Before you begin each part, you will be told how to do it and you will have some exercises to practice on.

Be sure to read the instructions so you will know what to do. If you do not understand the practice exercises, ask questions about them.

You will be told when to start and when to stop working.

Be sure to begin immediately when you are told to "Begin."

When you complete a page read the instructions at the bottom of the page so you will know whether to go on to the next page or to stop and wait for further instructions.

Work as quickly as you can without making mistakes.

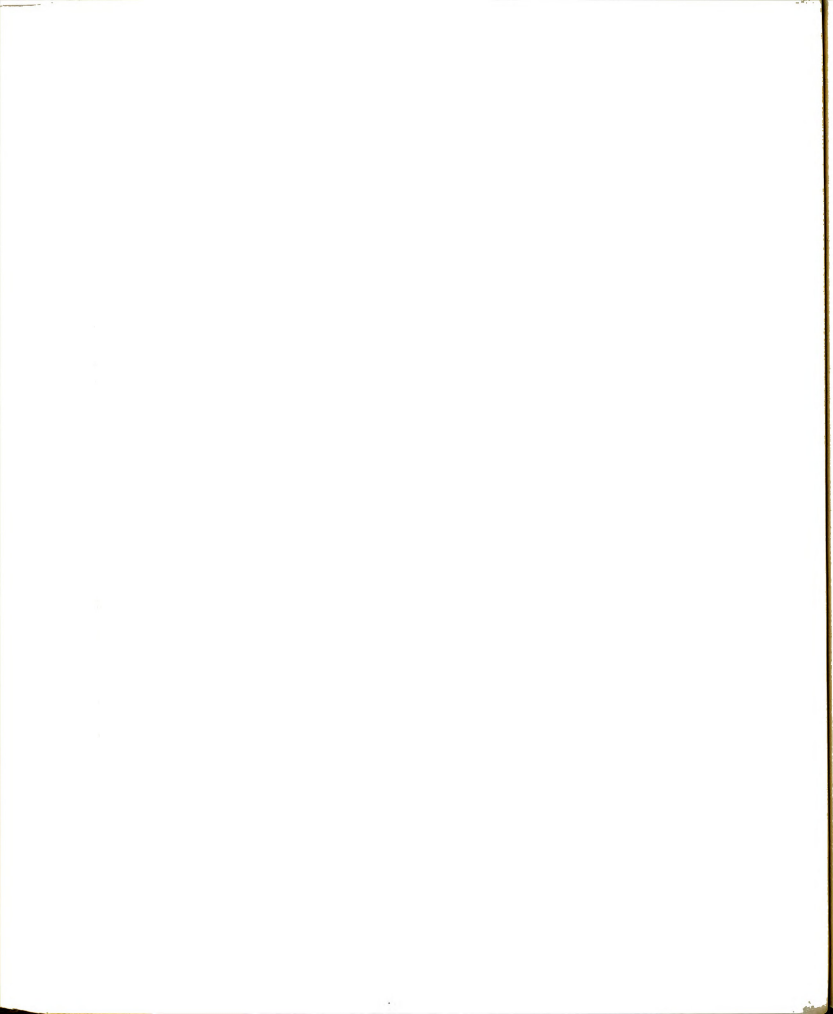
Stop immediately when you are told to "Stop."

You probably will not be able to finish in the time allowed, so do as much as you can.

You will indicate your answers by making pencil marks on a separate answer sheet. Make sure your answer marks are heavy and black. Erase completely any answer you wish to change. Use only the special pencils that are provided.

Make no marks on this booklet.

Do not turn this page until you are told to do so.

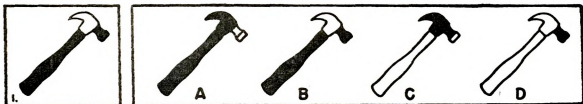


PART 5

INSTRUCTIONS

On this page are some exercises in comparing figures.

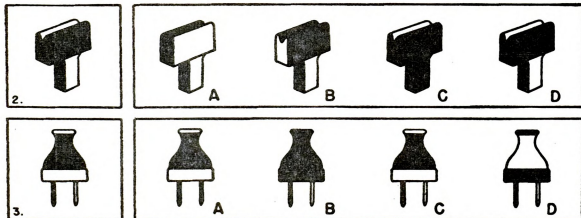
Look at exercise 1.



Notice that only figure B is exactly like figure 1 at the left.

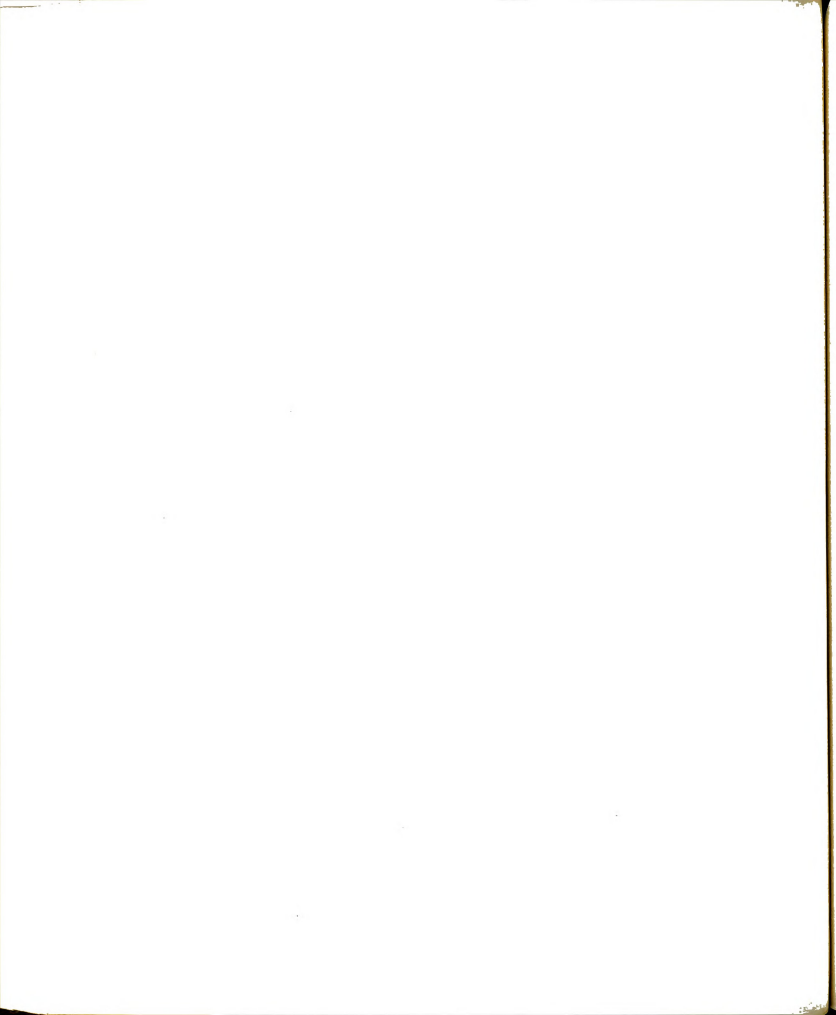
Look at the practice box in the Part 5 section of the answer sheet. Notice that in the row for practice exercise 1 the space under letter B has been filled in.

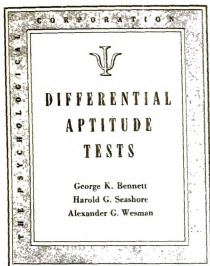
Here are some practice exercises. In each one find the lettered figure which is exactly the same as the numbered figure. Then blacken the space under the correct letter in the Part 5 Practice section of the answer sheet. Do not turn this page when you finish these two practice exercises. Make no marks in this booklet. Make heavy black marks in the answer spaces.



Do not turn this page until you are told to do so.

On the following pages are more exercises like these. Do them in the same way. Make no marks in this booklet. Make heavy black marks on the answer sheet. Work as fast as you can without making mistakes. You will be allowed 5 minutes.





MECHANICAL REASONING

FORM A

Do not open this booklet until you are told to do so.

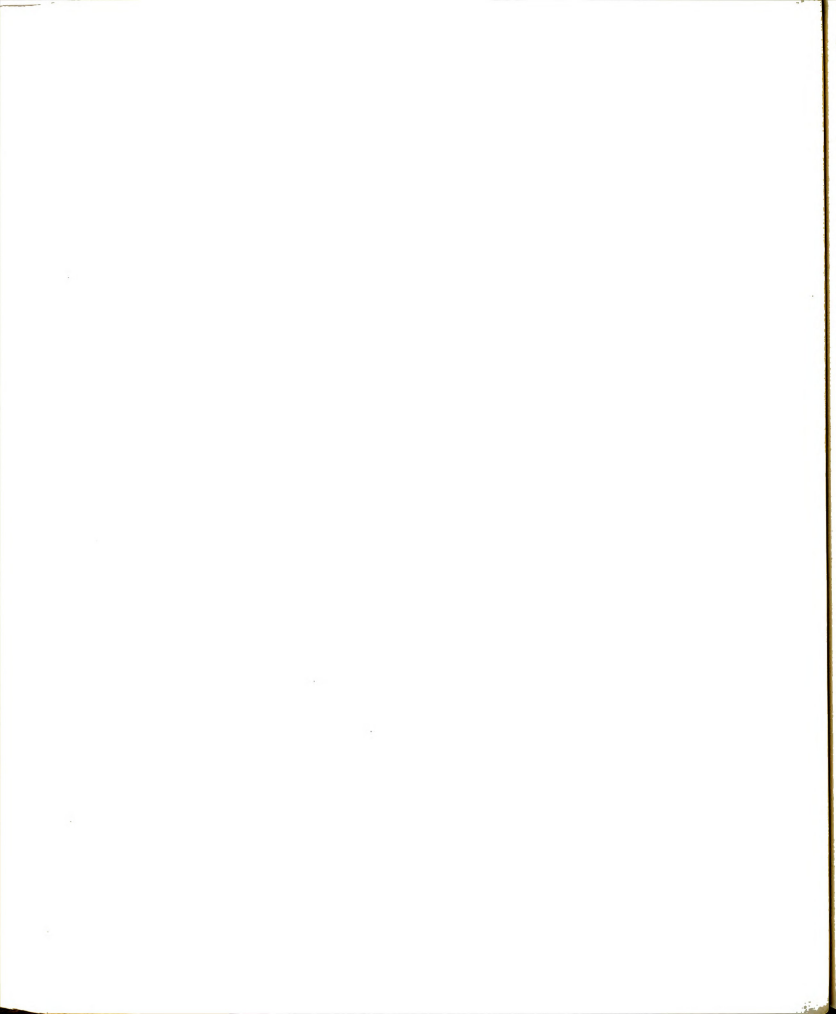
On your SEPARATE ANSWER SHEET, print your name, address, and other requested information in the proper spaces.

In the space after Form, print an A.

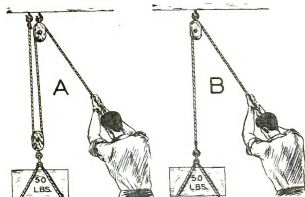
Then wait for further instructions.

DO NOT MAKE ANY MARKS IN THIS BOOKLET

Copyright 1947
The Psychological Corporation
522 Fifth Avenue
New York 18, N. Y.

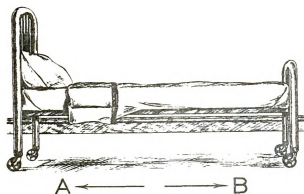


PUT YOUR ANSWERS ON THE ANSWER SHEET.



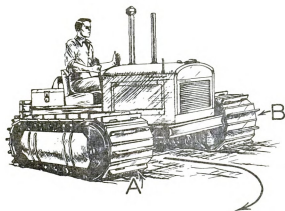
5

Which man must pull harder to lift the weight?
(If equal, mark C.)



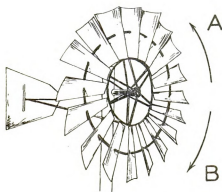
6

Which way has this bed just been rolled?
(If either, mark C.)



7

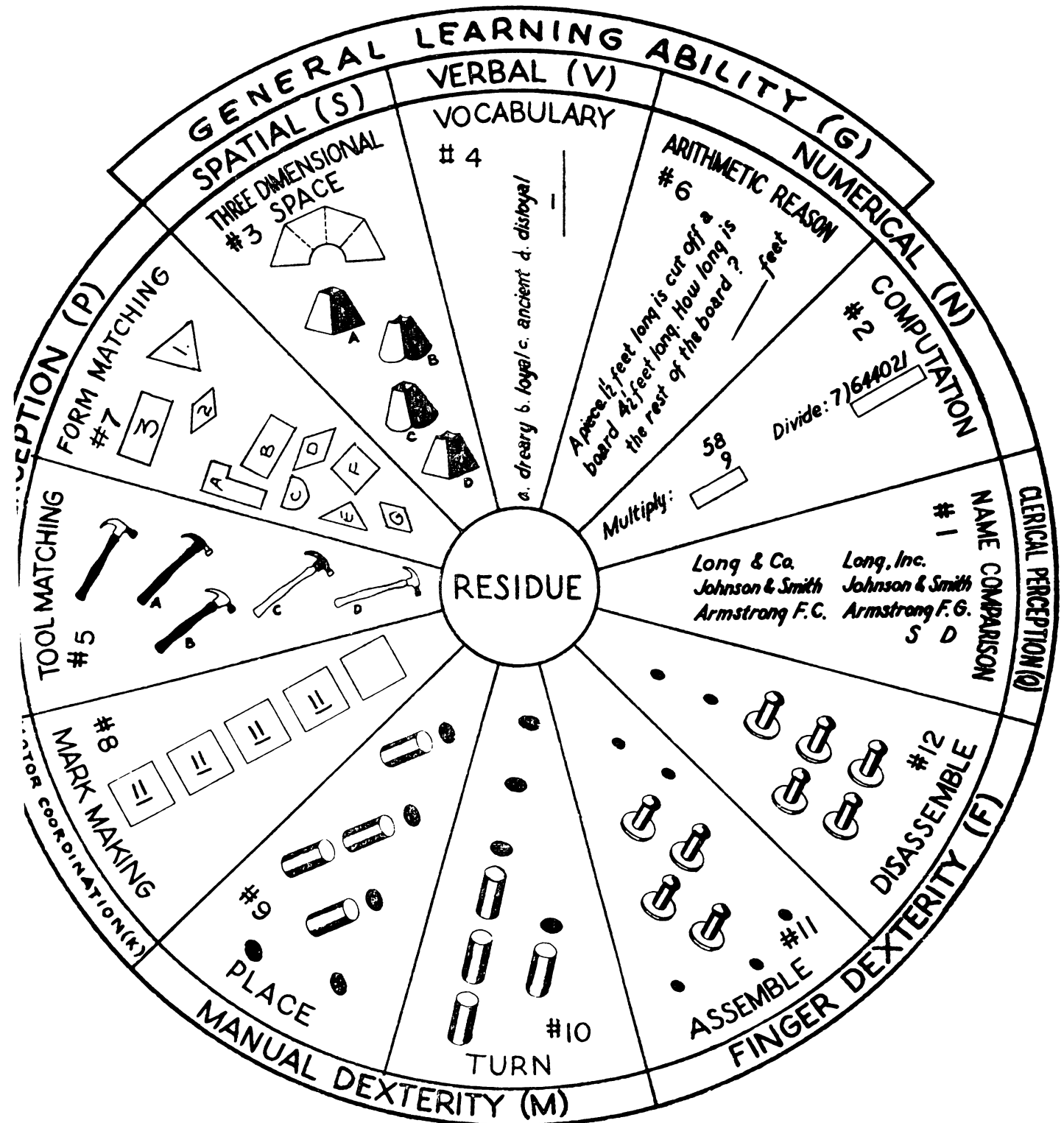
Which tread must stop for the tractor to turn in the direction shown?
(If neither, mark C.)

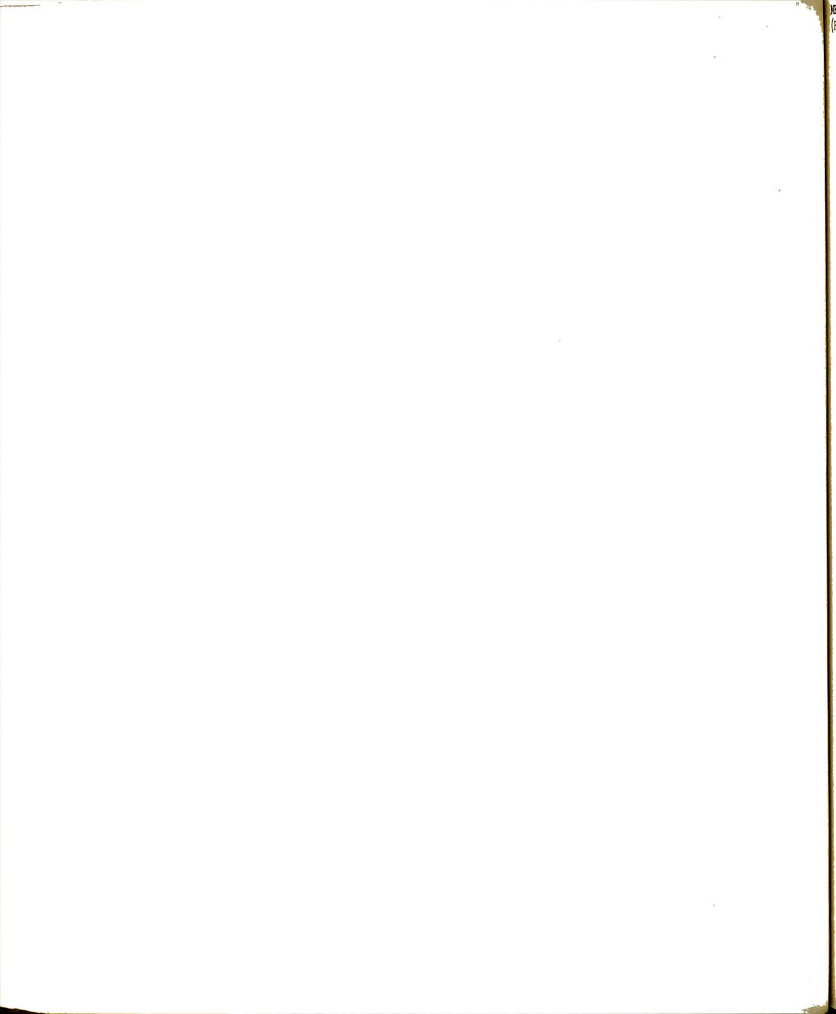


8

In which direction is this windmill more likely to turn?
(If either, mark C.)

The Nine Aptitudes Measured by the Twelve Tests in the General Aptitude Test Battery. (Courtesy Michigan Employment Security Commission, Form 2029, Revised 2-69)





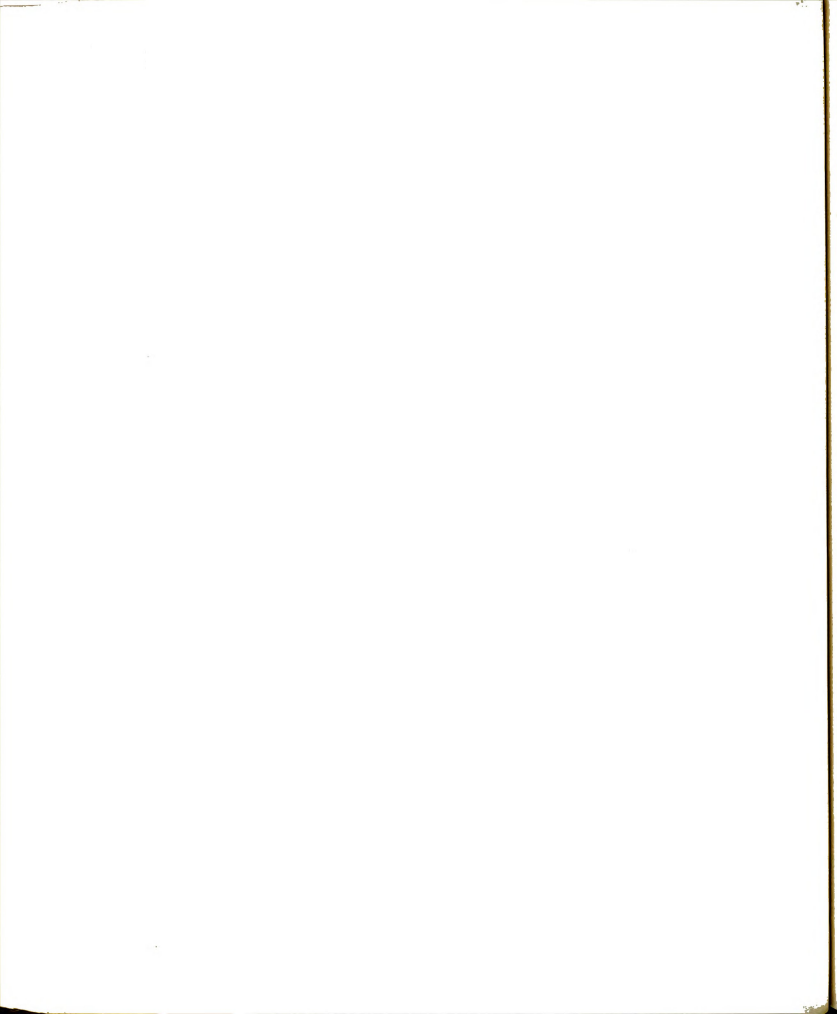
EMPLOYMENT SERVICE DIVISION

TEST UNIT

DEFINITIONS OF APTITUDES MEASURED BY B-1002

The nine aptitudes measured by B-1002 are defined below. The letter used as the symbol to identify each aptitude precedes each definition. The part or parts of the GATB measuring each aptitude follow each definition.

- G - General Learning Ability. -- The ability to "catch on" or understand instructions and underlying principles; the ability to reason and make judgments. Closely related to doing well in school. Measured by Parts 3, 4, and 6.
- V - Verbal Aptitude. -- The ability to understand meaning of words and ideas associated with them, and to use them effectively. The ability to comprehend language, to understand relationships between words and to understand meanings of whole sentences and paragraphs. The ability to present information or ideas clearly. Measured by Part 4.
- N - Numerical Aptitude. -- Ability to perform arithmetic operations quickly and accurately. Measured by Parts 2 and 6.
- S - Spatial Aptitude. -- Ability to think visually of geometric forms and to comprehend the two-dimensional representation of three-dimensional objects. The ability to recognize the relationships resulting from the movement of objects in space. Measured by Part 3.
- P - Form Perception. -- Ability to perceive pertinent detail in objects or in pictorial or graphic material. Ability to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines. Measured by Parts 5 and 7.
- Q - Clerical Perception. -- Ability to perceive pertinent detail in verbal or tabular material. Ability to observe differences in copy, to proofread words and numbers, and to avoid perceptual errors in arithmetic computation. Measured by Part 1.
- K - Motor Coordination. -- Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and swiftly. Probably related to reaction time. Measured by Part 8.
- F - Finger Dexterity. -- Ability to move the fingers, and manipulate small objects with the fingers, rapidly or accurately. Measured by Parts 11 and 12.
- M - Manual Dexterity. -- Ability to move the hands easily and skillfully. Measured by Parts 9 and 10.

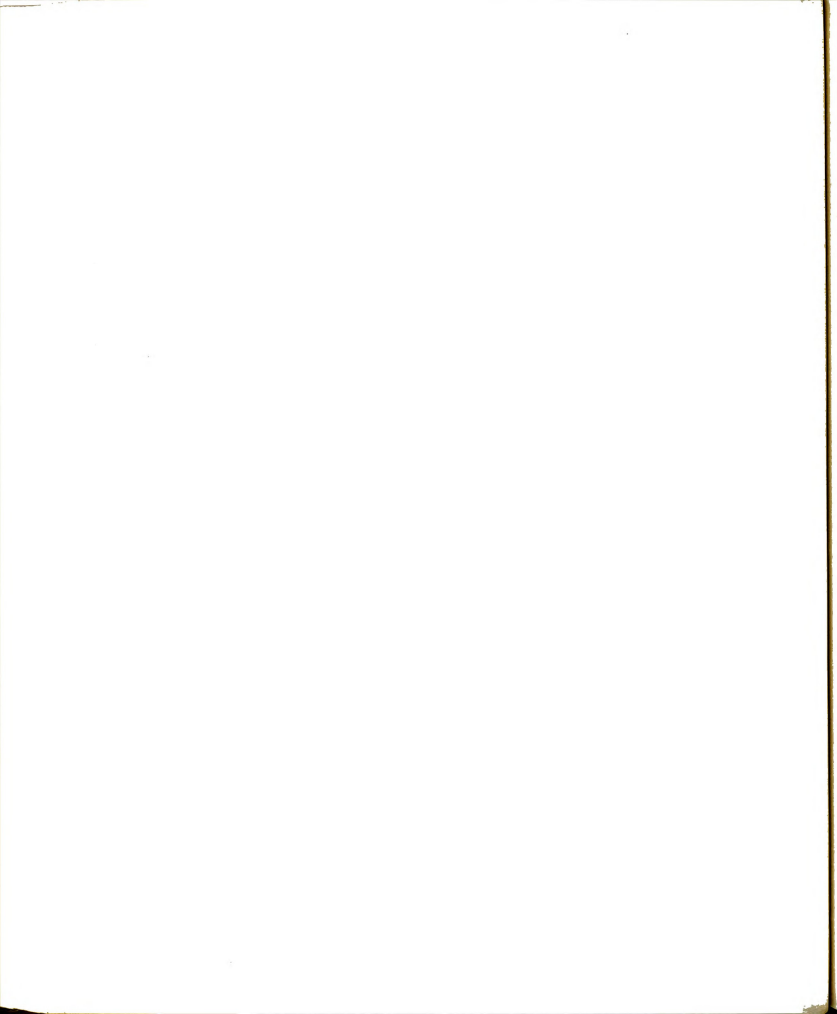


APPENDIX C

FORMS USED IN THE BASIC TRACTORS OPERATORS'

COURSE, GRADE I

1. Trainee Enrollment Record (EV-0)
2. General Aptitude Test Battery Series (EV-1)
3. Trainee Daily Training Evaluation (EV-2)
4. Trainee Permanent Record (EV-3)
5. Instructor's Daily Training Evaluation (EV-5)
6. Suggested Graduation Certificate
7. 1000-Hour Tractor Service Record
8. Pictorial "A" Daily (10-hr) Maintenance Guide Chart
9. Pictorial "B" Weekly (50-hr) Maintenance Guide Chart



TRAINEE ENROLLMENT RECORD

BASIC TRACTOR OPERATORS COURSE: GRADE I

Date _____

Training site _____ Course Sponsor _____

PERSONAL DATA

Name of Trainee _____ Nationality _____

Present Address _____

Date of Birth _____ Age _____

Home Address _____

Present Employer (if any) _____

Trainee's Sponsor _____

Type of Work You do _____

EDUCATION

School (s) Attended _____

Highest Grade Completed _____

Any Special Training Taken _____

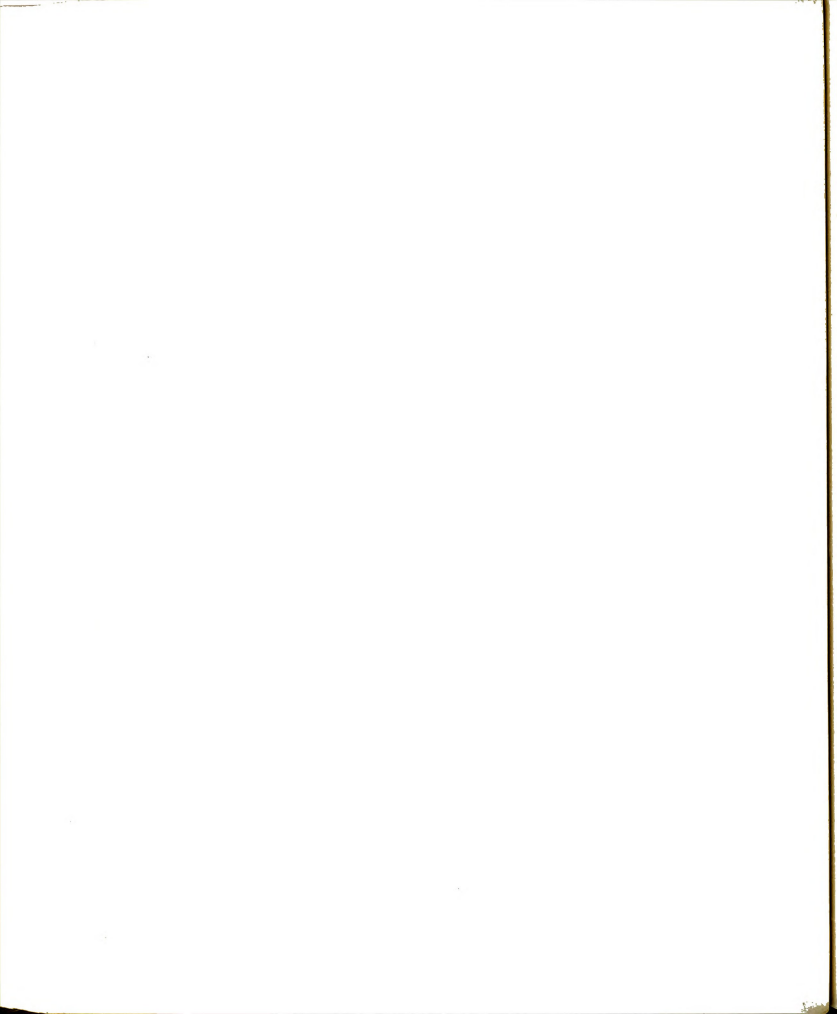
Special Skills Possessed (carpenter, blacksmith, etc.) _____

WORK EXPERIENCE

Farming _____

Factory _____

City _____



TRAINEE ENROLLMENT RECORD

BASIC TRACTOR OPERATORS COURSE: GRADE I

MECHANICAL EXPERIENCE

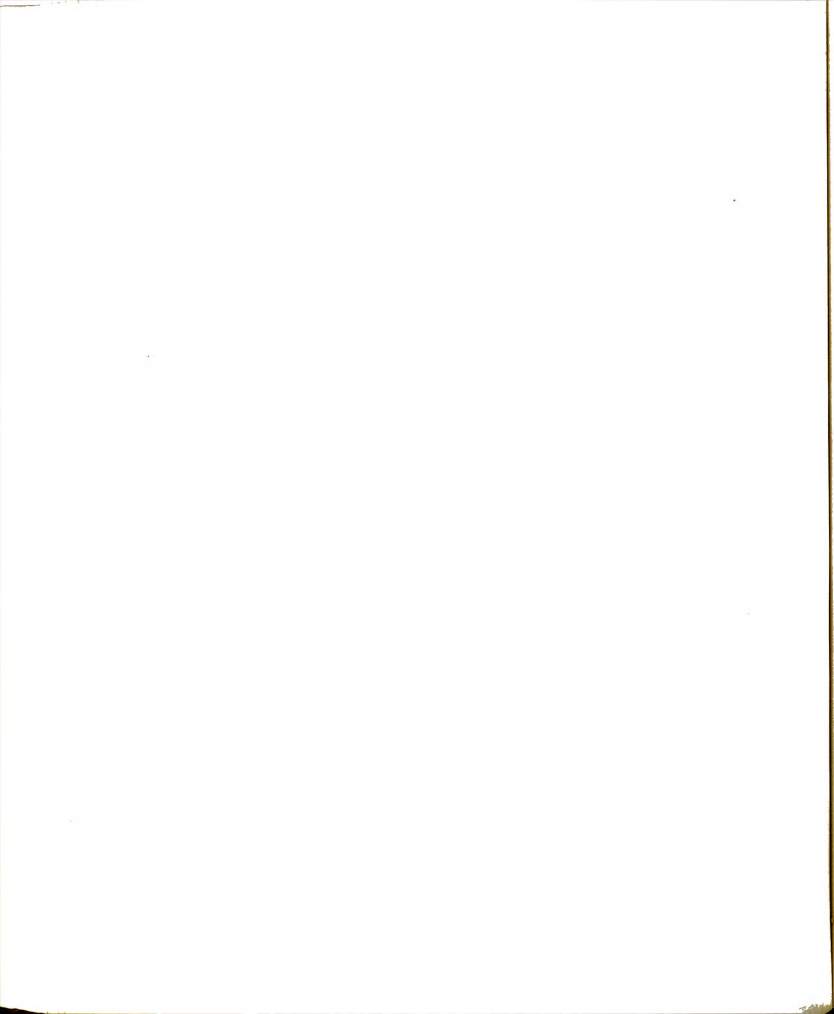
	<u>I have Ridden</u>	<u>I can Operate</u>	<u>I have Owned</u>	<u>I can Repair</u>	<u>No Experience</u>	<u>I am Licensed Operator</u>
Animal drawn implements	_____	_____	_____	_____	_____	_____
Bicycle	_____	_____	_____	_____	_____	_____
Automobile	_____	_____	_____	_____	_____	_____
Truck	_____	_____	_____	_____	_____	_____
Wheel tractor	_____	_____	_____	_____	_____	_____
Crawler tractor	_____	_____	_____	_____	_____	_____

WHAT DO YOU LIKE TO DO?

Read _____ Write _____ Sing _____ Weave _____
 Study _____ Go to School _____ Make things of Wood _____
 Make things of Metal _____ Make things of cloth/rope, etc. _____
 Work with Animals _____ Work with fruit/vegetables _____
 Work with Field Crops _____

I WANT TO BECOME A TRACTOR OPERATOR BECAUSE:

_____ I like mechanical things _____ I like to use machines
 _____ It is an important job in agriculture _____ It is a skilled job
 _____ It is easier than doing hand field work _____ I like to work outdoors
 _____ It will give me more job opportunities _____ It is a higher paying job
 _____ It will increase my standing with my friends _____ It makes me more important
 _____ I believe agriculture has a good future _____ My father wants me to



TRAINEE ENROLLMENT RECORD

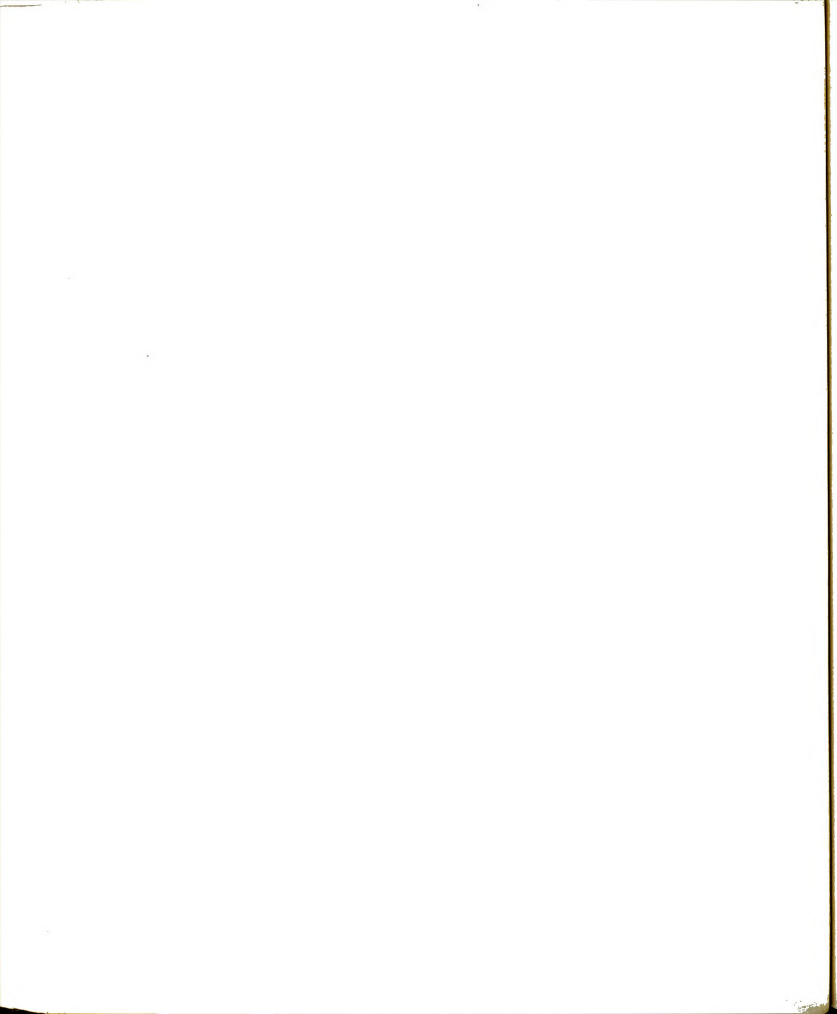
BASIC TRACTOR OPERATORS COURSE: GRADE I

I BELIEVE I WILL MAKE A GOOD TRACTOR OPERATOR BECAUSE:

- | | |
|--|---|
| ☐ I like to take care of machinery | ☐ I like to work alone |
| ☐ I like to work for somebody else | ☐ I like to make decisions |
| ☐ I like to do things in an orderly way | ☐ I like to use my hands |
| ☐ I believe that training is important | ☐ I want to continue to learn |
| ☐ I hope to have my own farm someday | ☐ I like to work with hand tools |
| ☐ I understand machinery | ☐ I practice safety |
| ☐ I am a careful worker | |

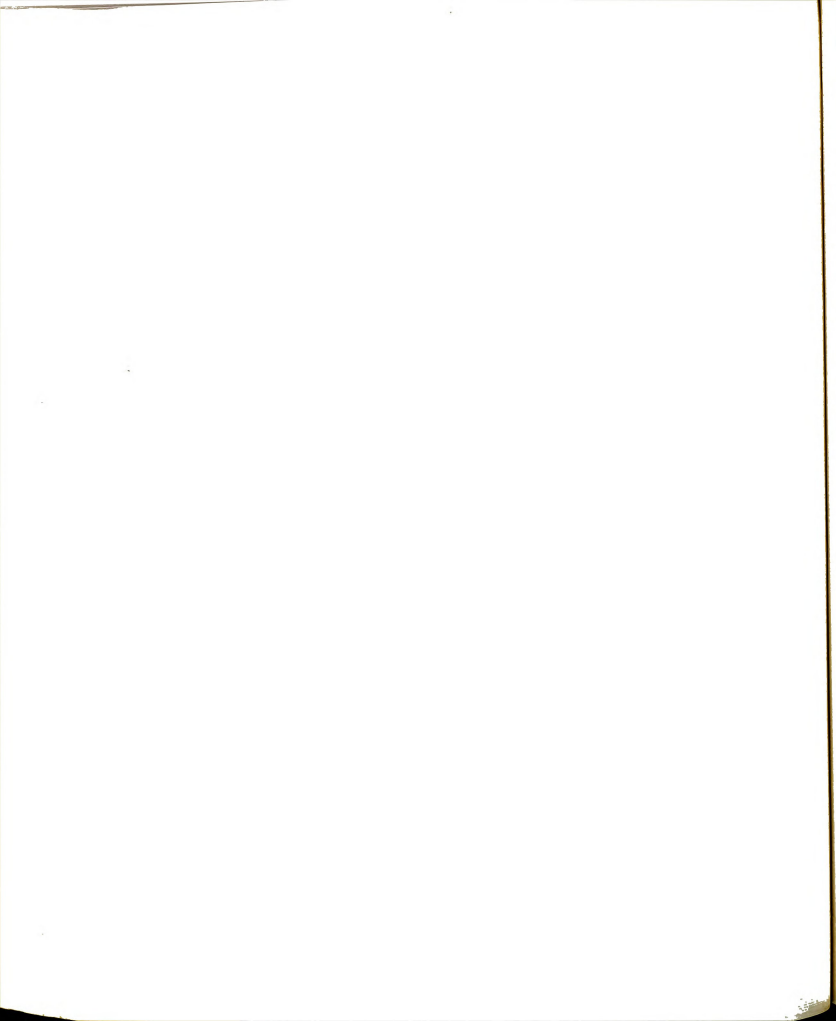
I HAVE USED THE FOLLOWING TOOLS AND EQUIPMENT

- | | |
|---|--|
| ☐ Hammer | ☐ Sprayer |
| ☐ Wrench | ☐ Duster |
| ☐ Screwdriver | ☐ Fertilizer spreader |
| ☐ Hand saw | ☐ Hand planter |
| ☐ Ruler | ☐ Pruning shears |
| ☐ File | ☐ Lawn mower |
| ☐ Post hole digger | ☐ Cultivator |
| ☐ Pick ax | ☐ Plow |
| ☐ Shovel | ☐ Disk |
| ☐ Hoe | ☐ Seeder |
| ☐ Grass cutter | ☐ Drill |
| ☐ Ax | ☐ Mower |
| | ☐ Other |



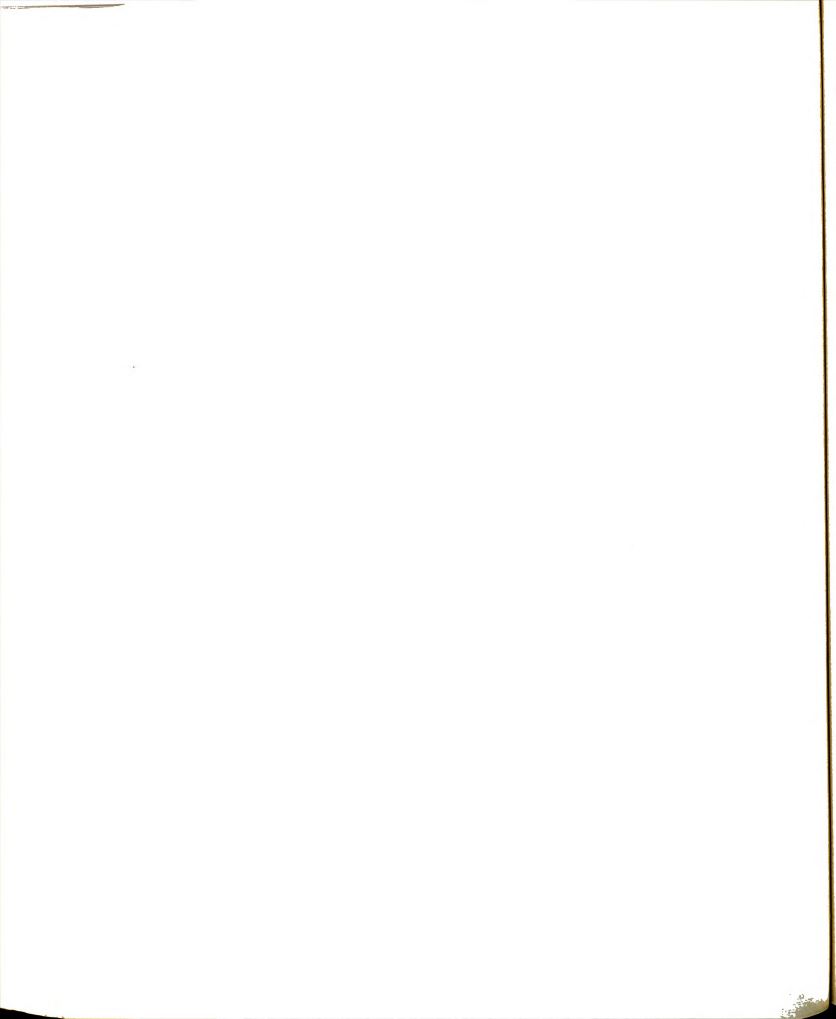
GENERAL APTITUDE TEST BATTERY SCORES*
FOR
BASIC TRACTOR OPERATORS COURSE TRAINEES

GATB Standard Score**		Name	Comp	Comput	3-Dim	Vocab	Tool	Arith	Form	Match	Mark	Place	Turn	Assem	Disassem
No.	Name	1*	2*	3	4*	5	6*	7	8	9	10	11	12		
*Converted test scores based on Dept. of Labor validations.															
**Based on closest cluster of machinery operator occupations.															
	1st														
	2nd														
	% Change														
	1st														
	2nd														
	% Change														
	1st														
	2nd														
	% Change														
	1st														
	2nd														
	% Change														



GENERAL APTITUDE TEST BATTERY SCORES*
FOR
BASIC TRACTOR OPERATORS COURSE TRAINEES

GATB Standard Score**		Name Comp	Comput	3-Dim Space	Vocab	Tool Match	Arith Reas	Form Match	Mark Make	Place	Turn	Assem	Disassem
No.	Name	1*	2*	3	4*	5	6*	7	8	9	10	11	12
	*Converted test scores based on Dept. of Labor validations.												
	**Based on closest cluster of machinery operator occupations.												
	1st												
	2nd												
	% Change												
	1st												
	2nd												
	% Change												
	1st												
	2nd												
	% Change												
	1st												
	2nd												
	% Change												
	1st												
	2nd												
	% Change												



TRAINEE DAILY TRAINING EVALUATION

Date _____

Evaluator _____

Name of Trainee	Daily Rating*		Key (*) Correct	Checkpoints Incorrect	Pre- test	Post- test	Final Rating*		Instructor's Remarks on Trainee's Progress
	A	S					A	S	
Lesson: _____									
1. _____									
2. _____									
3. _____									
4. _____									
5. _____									
Lesson: _____									
1. _____									
2. _____									
3. _____									
4. _____									
5. _____									
Lesson: _____									
1. _____									
2. _____									
3. _____									
4. _____									
5. _____									

*Rating Scale: "A" = + positive
 - negative
 0 neutral

"S" and "K" = 3 = Superior
 1 = Needs more work
 0 = Unqualified

2 = Qualified
 0 = Unqualified

Instructors:

TRAINEE RECORD1. _____
2. _____

Trainee _____

Location: _____

BASIC TRACTOR OPERATOR'S COURSE: GRADE I
SUMMARY OF TRAINING EVALUATION AND RATING

Date _____

	Evaluations						Tests					Evaluations						Tests			
	Daily			Final			Pre		Post			Daily			Final			Pre		Post	
	A	S	K	A	S	K					A	S	K	A	S	K					
A. <u>Getting Acquainted</u>											D. <u>Operating Tractor</u>										
1. Orientation											1. General Safety										
2. Tractor Nomenclature											2. Using Throttles										
3. Engine Care											3. Using Clutch										
4. Int. Comb. Engines											4. Using Transmission										
5. Tractor Operation											5. Steering Tractor										
6. Prelim. Driving											6. Reading Instrum.										
7. Power Transmission											7. Stop. Slow Tractor										
8. Hand Tools											8. Brake Fast Tractor										
B. <u>Prestarting Checks</u>											9. Parking Tractor										
1. Need for Maintenance											E. <u>Managing Tractor</u>										
2. Daily Maintenance											1. Difficult Tractor										
3. Fuel System											2. Avoid overloading										
4. Check and Add Fuel											3. Differential Lock										
5. Sediment Bowl											4. Break-in Tractor										
6. Air System											5. Records & Costs										
7. Air Precleaner											6. Slip & Traction										
8. Oil Bath Air Cleaner											7. Traf. Signs & Signals										
9. Dry Type Air Cleaner											8. Traffic Rules										
10. Engine Lubr. System											F. <u>Using Tractor</u>										
11. Service Crankcase											Power										
12. Greasing Tractor											1. Basic Pow. Systems										
13. Cooling System											2. Hitch to drawbar										
14. Service Cooling Sys											3. 3-Point Hitch										
15. Tires & Wheels											4. Attach. to 3-Pt.										
16. 50-hr Maintenance											5. Remote Hydr. Cyl.										
17. Battery & Electrical											6. 2-Wheel Trailer										
18. Maint. Records											7. 4-Wheel Wagons										
C. <u>Starting Engine</u>											G. <u>Safety Factors</u>										
1. Proceed. & Safety											1. Fuels & Lubricants										
2. Mount Tractor											2. Human Safety										
3. Adjust Seat											3. Tractor Safety										
4. Set Controls											H. <u>Tractor Farming</u>										
5. Start Engine											1. Disk Plowing										
6. Alternator light											2. Mldbrd. Plowing										
7. Oil Pres. Light											3. Disk Harrowing										
8. Temp. Gauge											4. Plant. & Cultivate										
9. Speed Hr. Meter											5. Spray. & Mowing										
											6. Other										

A = Attitude Rating: + = Positive - = Negative 0 = Neutral

S = Skills Rating: 0 = Unqualified 1 = Substandard 2 = Qualified 3 = Superior

K = Knowledge

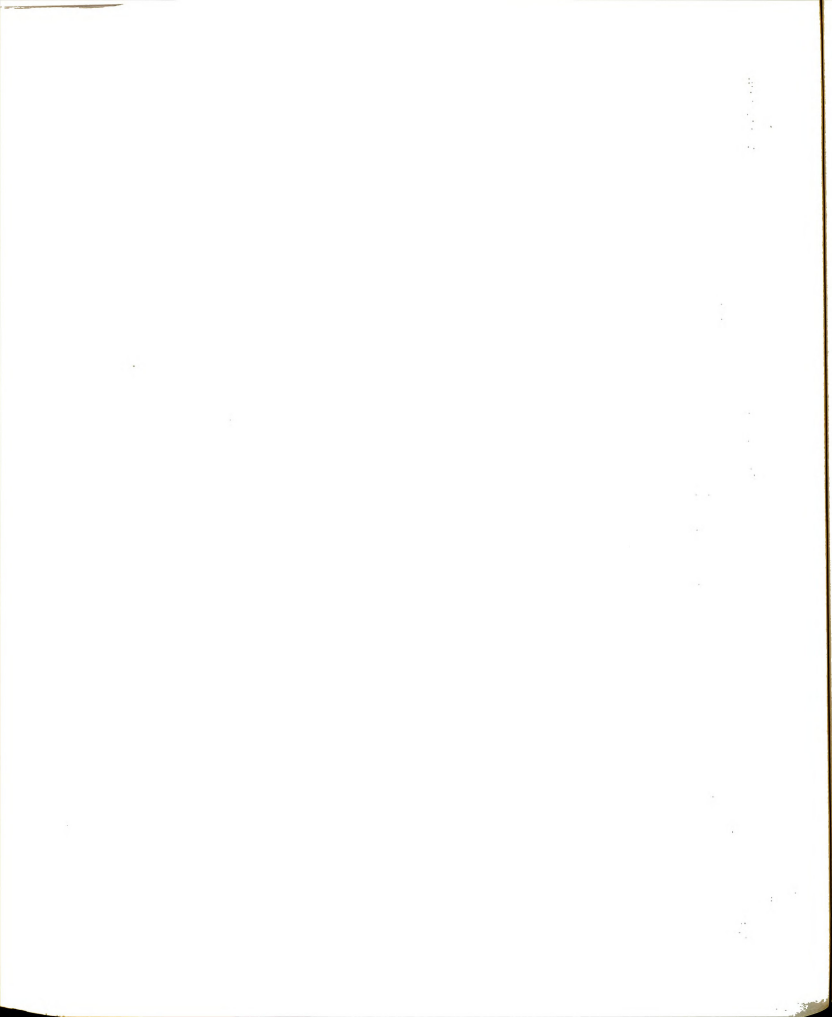
FINAL EVALUATION (Minimum Points)

Event 1 Driving Safety Class average _____
 Event 2 Two-wheel course Rank Class of: _____
 Event 3 Drawbar & PTO Final Rating: _____
 Event 4 Plowing Qualified _____
 Event 5 Daily Maintenance Unqualified _____
 Event 6 Weekly Maintenance Certificate issued: _____
 Event 7 Post tests Date: _____
 Total Points: _____ Official: _____

CATB SCORES

Test 1=Names _____
 Test 2=Compute _____
 Test 3=Space _____
 Test 4=Vocab _____
 Test 5=Tools _____
 Test 6=Season _____
 Test 7=Forms _____
 Test 8=Marking _____
 Test 9=Place _____
 Test 10=Turn _____
 Test 11=Assemble _____
 Test 12=Disassemble _____

INSTRUCTOR REMARKS



INSTRUCTOR'S DAILY TRAINING EVALUATION

April, 1970

Date _____

Lesson/s _____

Name _____

Instructors' CommentsTrainees' Comments

OBJECTIVES:

- Were they clear and well chosen?
- Were they met in the lesson and activities?
- What were the problem areas?
- What are your suggestions for additions or improvements?

INFORMATION:

- Was it appropriate for the students?
- Was it clear or confusing?
- Was it sufficient to cover the lesson?
- What were the problem areas?
- Suggestions for additions or improvements?

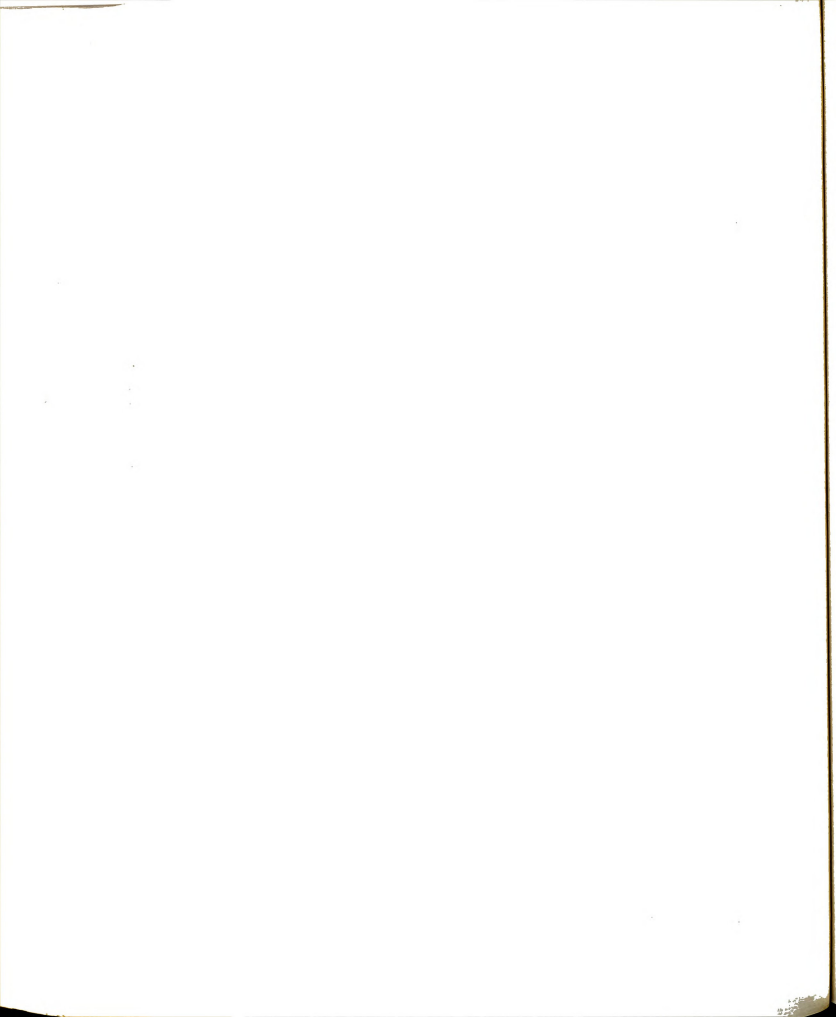
METHODS OF INSTRUCTION:

- Were they appropriate for the students and the lessons?
- Were they well received by the students?
- What were the problem areas?
- Suggestions for additions or improvements?

STUDENT EXERCISES:

- Were they appropriate and necessary?
- How were the students all kept busy?
- What were the problem areas?
- Suggestions for additions or improvements?

Please use the reverse side to comment further if the allotted space is insufficient. Also, if any information or methods were used that are not included in the Teachers manual, please indicate and comment on their effectiveness.



Michigan State University

COOPERATIVE EXTENSION SERVICE

Certificate of Recognition to

for meeting the qualifications of

BASIC TRACTOR OPERATOR GRADE 1

DATE _____

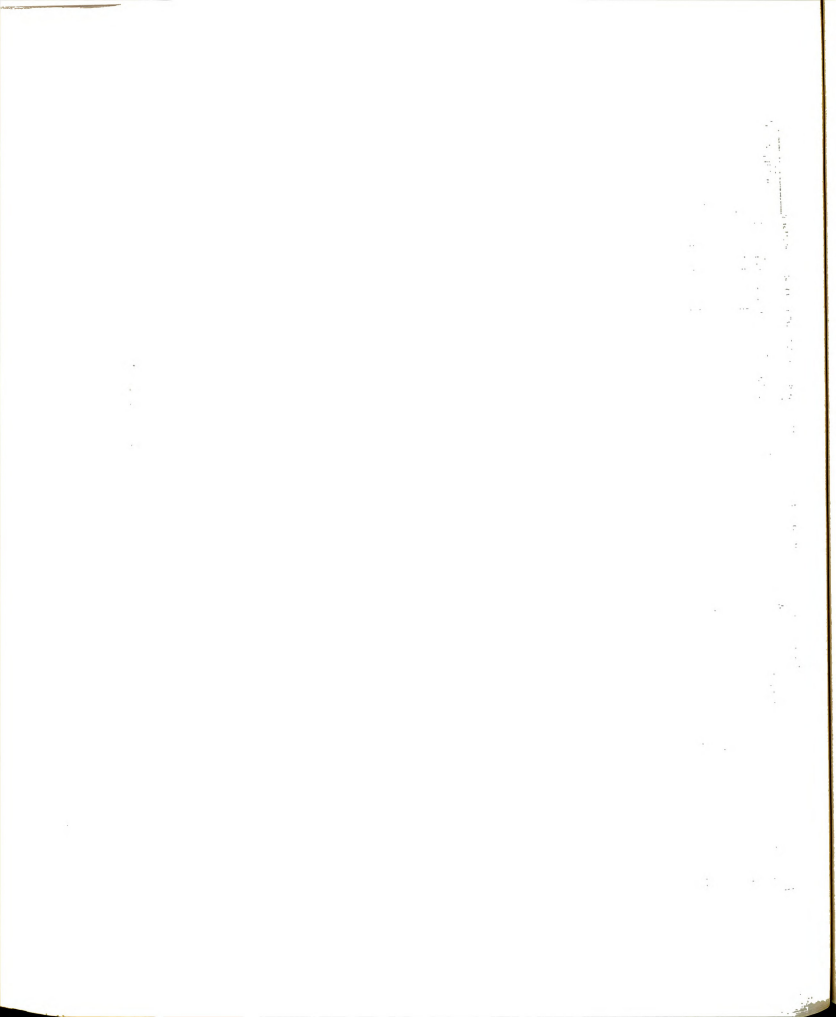


NAME _____

NAME _____

TITLE _____

TITLE _____



TRACTOR SERVICE RECORD - HOURS OF ENGINE OPERATION: JOHN DEERE 2020 TRACTOR NUMBER

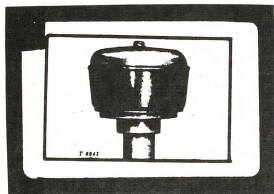
TRACTOR NUMBER

[illegible]

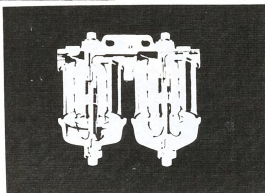
Tractor Operator's Name

DATE SERVICE BEGAN

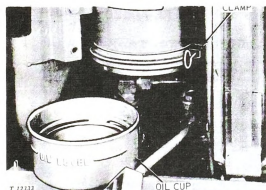


"A" DAILY (10 Hr.) MAINTENANCE GUIDE CHART

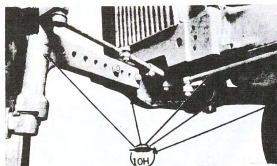
1. Check Air Precleaner



5. Check Fuel Filter Sediment Bowl

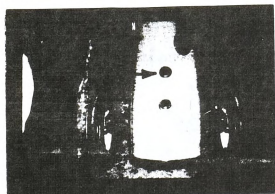


2. Check Oil Bath Air Cleaner



Front Axle Grease Fittings

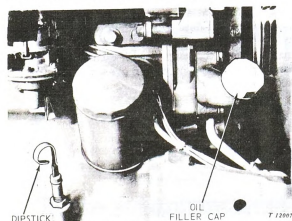
6. Grease Tractor and Implement



3. Check Radiator Water Level



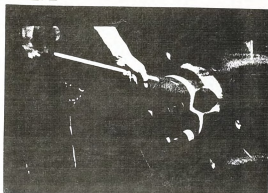
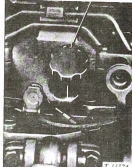
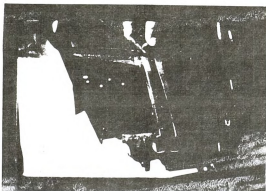
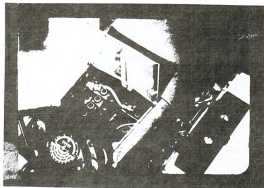
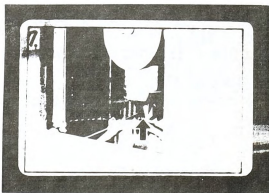
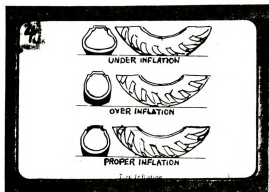
7. Inspect Tires and Wheels

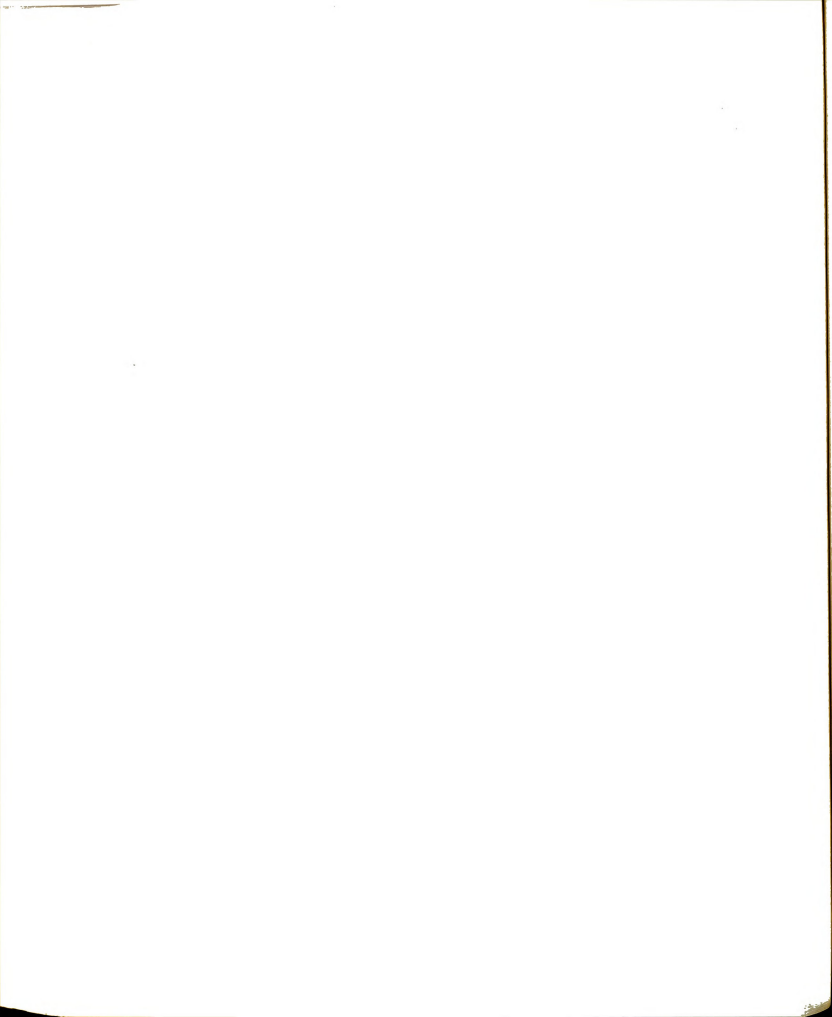


4. Check Crankcase Oil Level



8. Check Fuel Tank Level & Refill

"B" 50-Hour MAINTENANCE GUIDE CHARTTRANSMISSION - HYDRAULIC
SYSTEM DIPSTICK RESTING
ON TOP THREADS**1. Check Hydraulic Oil Level**TRANSMISSION - HYDRAULIC
SYSTEM FILLER CAP**5. Check Wheel & Lug Nuts and Tires****2. Check Brake Action****6. Check Battery & Electrical System****3. Check Clutch Free Travel (1")****7. Check Dry-Type Air Cleaner****4. Check Tire Air Pressure****8. Check Hr-meter & Record Maintenance**



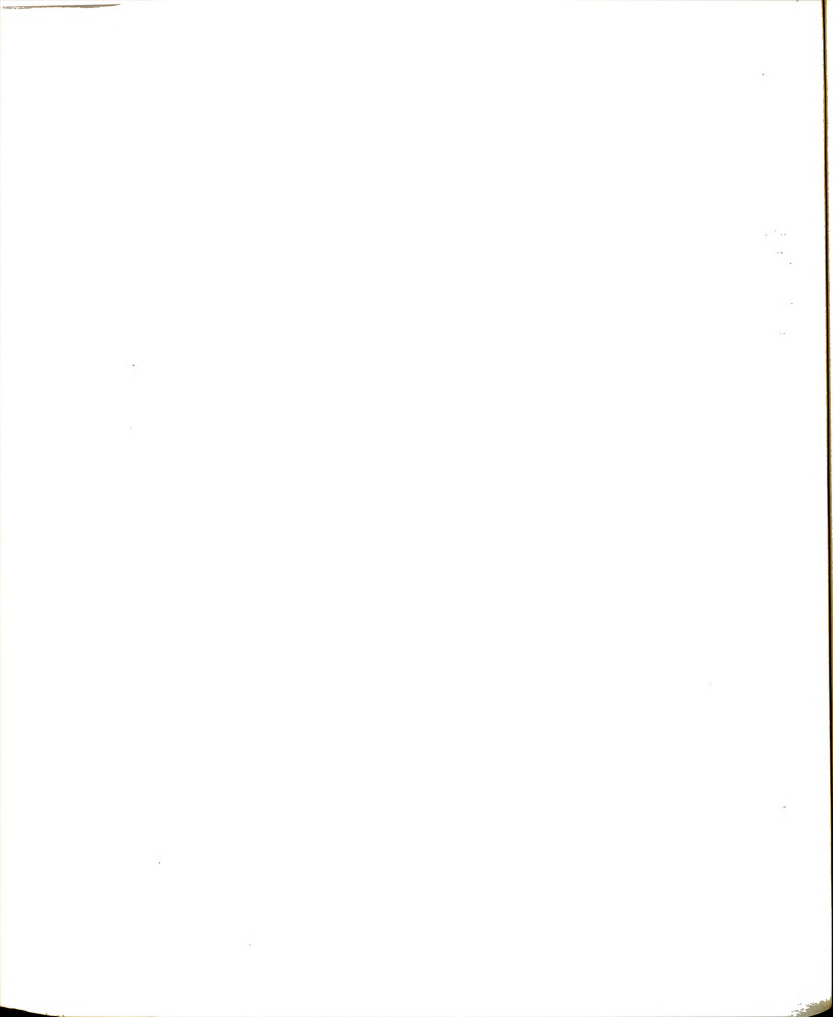
APPENDIX D

FINAL EVALUATION EVENTS USED IN THE BASIC

TRACTOR OPERATORS' COURSE, GRADE I

1. Event No. 1: Driving Safety
2. Event No. 4: Hitching, Adjusting, Plowing with
and Unhitching a Moldboard Plow
3. Event No. 6: Performing the Weekly (50-hr)
Maintenance Services

(Events 2, 3, 5 and 7 not included here.)



FINAL EVALUATION

EVENT NO. 1
DRIVING SAFETYProcedure

Contestant No. _____

Each contestant will be scored on safety any time he is concerned with tractor operation. This includes the practice period as well as before, during and after the driving events. Safety judges will be on hand to record violations during these periods.

ScoringStarting Safety

No. of times

Points added

- | | | |
|---|---------|-----------|
| 1. Failure to check neutral position. | _____ x | 100 _____ |
| 2. Failure to disengage clutch while starting engine. | _____ x | 10 _____ |
| 3. Failure to check disengaged position of PTO. | _____ x | 50 _____ |

Driving Safety

- | | | |
|--|---------|-----------|
| 1. Failure to engage clutch gently. | _____ x | 10 _____ |
| 2. Failure to ride on seat or stand safely on platform. | _____ x | 100 _____ |
| 3. Skidding or spinning wheels when starting. | _____ x | 50 _____ |
| 4. Turning too short and fouling implement. | _____ x | 20 _____ |
| 5. Operation of tractor at unsafe speed. | _____ x | 100 _____ |
| 6. Moving tractor with brake set. | _____ x | 10 _____ |
| 7. Inadequate precautions when officials, other contestants, etc., get in the way. | _____ x | 100 _____ |
| 8. Any turn which causes inside rear wheel to leave the ground. | _____ x | _____ |

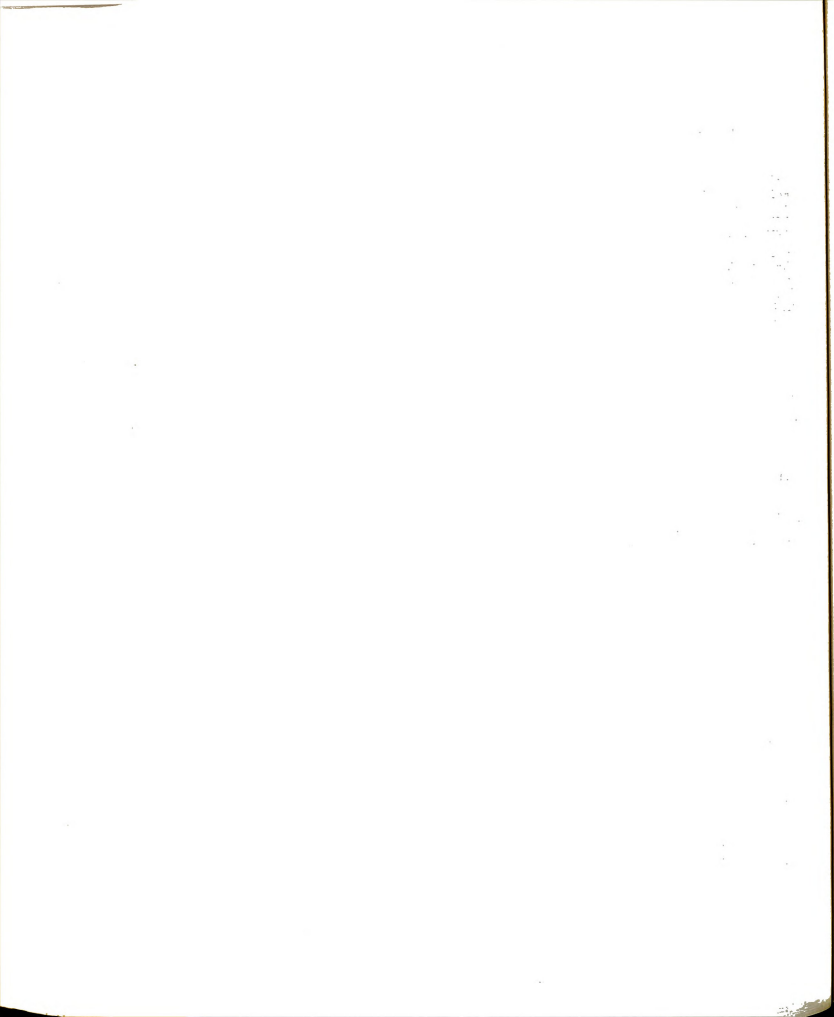
Disqualifies ContestantMounting and Dismounting Safety

- | | | |
|--|---------|-----------|
| 1. Failure to set brake before dismounting. | _____ x | 50 _____ |
| 2. Failure to dismount to insert or remove drawbar pin. | _____ x | 20 _____ |
| 3. Failure to bring tractor to complete stop before dismounting. | _____ x | 100 _____ |
| 4. Failure to mount and dismount safely. | _____ x | 50 _____ |

Other Safety

- | | | |
|----------------------------|---------|-----------|
| 1. Smoking. | _____ x | 20 _____ |
| 2. Extra riders. | _____ x | 100 _____ |
| 3. Loose fitting clothing. | _____ x | 50 _____ |
| 4. _____ | _____ x | _____ |
| _____ | _____ x | _____ |
| _____ | _____ x | _____ |

Total Points Added _____



EVENT NO. 4

HITCHING, ADJUSTING, PLOWING WITH AND UNHITCHING A MOLDBOARD PLOW

Contestant No. _____

Procedure

Two judges will be used for timing, observing and measuring and marking scores. One judge should watch safety practices and keep time. No assistance will be permitted in hitching or adjusting the implement. The 3-point hitch will be thrown out of adjustment by turning the right lift link a number of turns.

The contestant or trainee will start and warm up the tractor at the starting line. On sign from the judge he will back up to the plow, spot the tractor, set the transmission in Park or Lock and/or at least one brake when the tractor is so equipped, and dismount. Then he will connect the plow making sure the fixed or swinging drawbar is in the short position. After checking the plow for damage, worn or missing parts he will connect the left drawbar link first, the right link second and the center top link last. The plow should be raised slowly with the hydraulic lever and then leveled approximately from front to rear and side to side. The operator then drives to the furrow, lowers the plow into the ground and drives a short way to check the plow's performance.

If the plow is not properly set, the operator should correct the adjustments. The depth control should be set for 7 to 9 inches and the LD lever set in one of the LD positions to give both depth and load control. The moldboard plow should adequately cover the trash. All furrows should be the same size with the plow properly leveled. The operator should drive with the right wheel in the furrow without crowding the furrow wall or running up on the previously plowed land. The tractor wheel spacing is preset for the correct cut of the first bottom. The rolling coulters should slice the trash and make a clean furrow wall. The tail wheel should counter the side thrust on the tractor for easy steering.

At the end of the land the operator should lift the plow at the correct point and make his turn. He may slow down the engine for better control in turning out of and into the next furrow. For this exercise he will complete one round. For best plowing he should match the load to the proper gear and engine speed. Plowing will probably be done in third gear, although conditions could require one gear lower or permit one gear higher for best results. The throttle should be set for full power at 2500 rpm under load. At the end of the return trip he should lift the plow at the proper point and return to the starting area. The contestant will unhitch the plow and park the tractor at the starting line.

Rules

1. Safety will be observed at all times using the score sheet for Event No. 1. Ten percent of the safety score will be added to the plowing score.
2. Whenever dismounting from the tractor, the transmission must be in "Park" or "Lock" and/or at least one brake set.
3. This is not a speed event but points will be deducted after exceeding a reasonable time. Time begins on signal from the judge at the starting line and stops when the particular operation under test is completed, such as hitching, plowing and unhitching.
4. A penalty will be assessed for plowing at depths either shallower than 7 inches or deeper than 9 inches, and also for nonuniform depths.
5. All adjustments, including depth settings, must be made by the contestant himself.
6. The quality of plowing will be judged on: (a) evenness of crowns; (b) straightness of furrows; (c) uniform depth of furrows; (d) proper depth of furrows; (e) proper entry and removal at headlands; (f) trash coverage; (g) general appearance and control; and (h) the straightness and coverage of backfurrows and deadfurrows if used.

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EVENT NO. 4

HITCHING, ADJUSTING, PLOWING WITH AND UNHITCHING A MOLDBOARD PLOW Page 2

Contestant No. _____

Procedure

The purpose of this event is to test the operator's skill and knowledge in using the tractor with an implement to perform a basic farm production operation effectively and economically. Each contestant or trainee will be scored on safety before, during, and after driving events.

Scoring

<u>Hitching</u>	3-point Plow (Time Start _____ Time Finish _____)	No. of times	Points added
1.	Each extra pull-up to spot tractor.	_____ x	10 _____
2.	Failure to put transmission in Park or Lock.	_____ x	10 _____
3.	Failure to put drawbar in short position.	_____ x	10 _____
4.	Failure to set selector lever in "D" position.	_____ x	10 _____
5.	Connecting center or top length before draft links.	_____ x	10 _____
6.	Connecting right draft link before left draft link.	_____ x	10 _____
7.	Poor spotting of tractor or lift arm making hitching difficult.	_____ x	10 _____
8.	Failure to insert and lock quick-lock pins.	_____ x	10 _____
9.	Failure to back up to lock draft link extensions.	_____ x	10 _____
10.	Failure to lock adjusting handle on top center link.	_____ x	10 _____
11.	Raising implement too rapidly and not checking for bind.	_____ x	10 _____
12.	Total time exceeding 300 seconds.	_____ sec. x 1/4	_____

Plowing Moldboard Plow (Time Start _____ Time Finish _____)

1.	Failure to reset selector lever into one of LD positions.	_____ x	10 _____
2.	Failure to lower plow at correct point at headland.	_____ x	10 _____
3.	Failure to level plow from front to rear.	_____ x	20 _____
4.	Failure to level plow from side to side.	_____ x	20 _____
5.	Failure to readjust coulter if needed.	_____ x	10 _____
6.	Crowding furrow wall with right front or rear wheel.	_____ x	10 _____
7.	Driving erratically or zigzagging.	_____ x	10 _____
8.	Driving in too high or too low a gear for conditions.	_____ x	10 _____
9.	Failure to look back and check work of the plow.	_____ x	10 _____
10.	Failure to raise plow at correct point at headland.	_____ x	10 _____
11.	Total time exceeding 900 seconds.	_____ sec. x 1/4	_____

Quality of Plowing

1.	Furrows not even and crowned.	_____ x	10 _____
2.	Furrows not straight.	_____ x	10 _____
3.	Plowing depth less than 7 or greater than 9 inches.	_____ x	10 _____
4.	Right bottom cutting too wide a furrow.	_____ x	10 _____
5.	Coulters not slicing sod and trash properly.	_____ x	10 _____
6.	Depth of plowing not uniform, varying more than 1 in.	_____ x	10 _____

Operation of Tractor-Plow Unit

1.	Throttle not set for full power.	_____ x	10 _____
2.	Overloading or lugging the engine.	_____ x	10 _____
3.	Spinning wheels or digging in.	_____ x	10 _____
4.	Riding clutch or brakes.	_____ x	10 _____

Unhitching (Time Start _____ Time Finish _____)

1.	Failure to remove top center link first.	_____ x	10 _____
2.	Failure to replace quick lock pins in 3-point hitch.	_____ x	10 _____
3.	Pulling away too quickly and/or upsetting implement.	_____ x	10 _____
	Total time exceeding 200 seconds	_____ sec. x 1/4	_____

Total Raw Score Hitching _____ Plowing _____ Quality _____ Operation _____ Unhitching _____

1. The first part of the report
 2. The second part of the report
 3. The third part of the report
 4. The fourth part of the report
 5. The fifth part of the report
 6. The sixth part of the report
 7. The seventh part of the report
 8. The eighth part of the report
 9. The ninth part of the report
 10. The tenth part of the report

11. The eleventh part of the report
 12. The twelfth part of the report
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 27. The twenty-seventh part of the report
 28. The twenty-eighth part of the report
 29. The twenty-ninth part of the report
 30. The thirtieth part of the report

31. The thirty-first part of the report
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 35. The thirty-fifth part of the report
 36. The thirty-sixth part of the report
 37. The thirty-seventh part of the report
 38. The thirty-eighth part of the report
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 40. The fortieth part of the report

41. The forty-first part of the report
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 45. The forty-fifth part of the report
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 48. The forty-eighth part of the report
 49. The forty-ninth part of the report
 50. The fiftieth part of the report

51. The fifty-first part of the report
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 57. The fifty-seventh part of the report
 58. The fifty-eighth part of the report
 59. The fifty-ninth part of the report
 60. The sixtieth part of the report

61. The sixty-first part of the report
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 63. The sixty-third part of the report
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 65. The sixty-fifth part of the report
 66. The sixty-sixth part of the report
 67. The sixty-seventh part of the report
 68. The sixty-eighth part of the report
 69. The sixty-ninth part of the report
 70. The seventieth part of the report

EVENT NO. 6

PERFORMING THE WEEKLY (50-HOUR) MAINTENANCE SERVICES

Procedure

Contestant No. _____

This exercise is designed to test the trainee's knowledge and ability to perform the 50-hour maintenance services. The trainee should be able to recognize the need for, check and perform correctly the services called for at the end of each 50 hours as indicated on the speed-hour meter. Only one trainee should be present at a time for evaluation and the trainees should not explain the test to other trainees who have not been evaluated.

Preconditions

Before the trainee is asked to carry out the needed maintenance the tractor should be prepared by setting up the following conditions:

1. Speed-hour meter should read a multiple of 50 (tape can be used).
2. Record forms should be available.
3. Transmission oil should be one quart low.
4. Various types of oil (including transmission oil) should be available.
5. Rags and equipment for filling transmission should be available.
6. Loose battery cable (corroded if possible).
7. Loose battery hold-down strap.
8. Two battery cells with low electrolyte level.
9. One rear light that doesn't work.
10. Clutch with insufficient clutch "free travel".
11. Brakes out of adjustment.
12. One tire with insufficient air pressure (preferably rear tire).
13. One tire with excess air pressure (preferably front tire).
14. One valve stem (on rear tire loaded with water) in lowest position.
15. Total of three loose lug nuts on various wheels.
16. Restriction indicator showing red for dry-element air cleaner.
17. Dirty element in dry-filter-type air cleaner.
18. Tractor on a sloping surface.

When these conditions are ready the instructor may proceed to give the trainee the following instructions: CHECK THE SPEED-HOUR METER AND PERFORM THE REQUIRED MAINTENANCE ON THIS TRACTOR. Since Event No. 5 evaluated the trainee's proficiency in performing the daily maintenance services the instructor may simply ask the trainee to name the daily services he would perform first.

Mark off the number before each item as the trainee correctly makes each check. Place the appropriate number in each blank indicating the number of times the trainee failed to make the required checks. EXAMPLE: If the trainee failed to check three battery cells for electrolyte level, place the number three (3) in the blank under "No. of Times." This number is multiplied by 5 to give 15 points in the blank on the right.

If the trainee fails to make a check and indicates that he is finished, the instructor should mark that he failed to make that check. The instructor should then ask the trainee to perform the checks that were neglected and proceed to determine the trainee's proficiency at performing those checks.

When the trainee reaches the point of beginning to correct a faulty situation the instructor may stop the trainee and instruct him to proceed on to other checks. This will facilitate leaving the same conditions for each trainee being evaluated. EXAMPLE: When the trainee has determined that the oil level in the transmission is low he should get the correct oil to add to the transmission. At the point at which he is about to pour in the oil the instructor should stop him and ask him to proceed as if the oil had been added. On the tires the instructor can ask how much air should be added or released.

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EVENT NO. 6

PERFORMING THE WEEKLY (50-HOUR) MAINTENANCE SERVICES Page 2

Total Time Used _____

Contestant No. _____

ScoringSpeed-hour Meter

<u>No. of Times</u>	<u>Points Added</u>
_____ x	10 _____
_____ x	10 _____
_____ x	10 _____

1. Failed to read speed-hour meter correctly.
2. Failed to record hours correctly.
3. Failed to perform daily maintenance services.

Transmission and Hydraulic Oil

1. Failed to check oil level.	_____ x	20 _____
2. Failed to level tractor before checking.	_____ x	10 _____
3. Did not know where to check oil.	_____ x	10 _____
4. Failed to have engine running while checking.	_____ x	10 _____
5. Failed to have rockshaft lowered while checking.	_____ x	10 _____
6. Failed to clean around dipstick and/or filler cap.	_____ x	10 _____
7. Failed to wipe off and replace dipstick before reading.	_____ x	10 _____
8. Failed to read dipstick correctly.	_____ x	10 _____
9. Failed to choose correct oil.	_____ x	10 _____
10. Failed to add correct amount of oil.	_____ x	10 _____
11. Did not know where to add oil.	_____ x	10 _____
12. Failed to replace dipstick and/or cap tightly.	_____ x	10 _____

Battery and Electrical System

1. Failed to check battery cells for electrolyte.	_____ x	5 _____
2. Failed to check battery cables for tightness.	_____ x	10 _____
3. Failed to check battery terminals for corrosion.	_____ x	10 _____
4. Failed to add distilled water to low cells.	_____ x	5 _____
5. Failed to check and tighten hold-down clamps.	_____ x	10 _____
6. Failed to check tractor lights (front and rear).	_____ x	5 _____
7. Failed to wash hands after checking battery.	_____ x	10 _____

Brakes

1. Failed to check brakes for sponginess and report.	_____ x	10 _____
2. Failed to check brakes for uneven action and report.	_____ x	10 _____

Clutch Free Travel

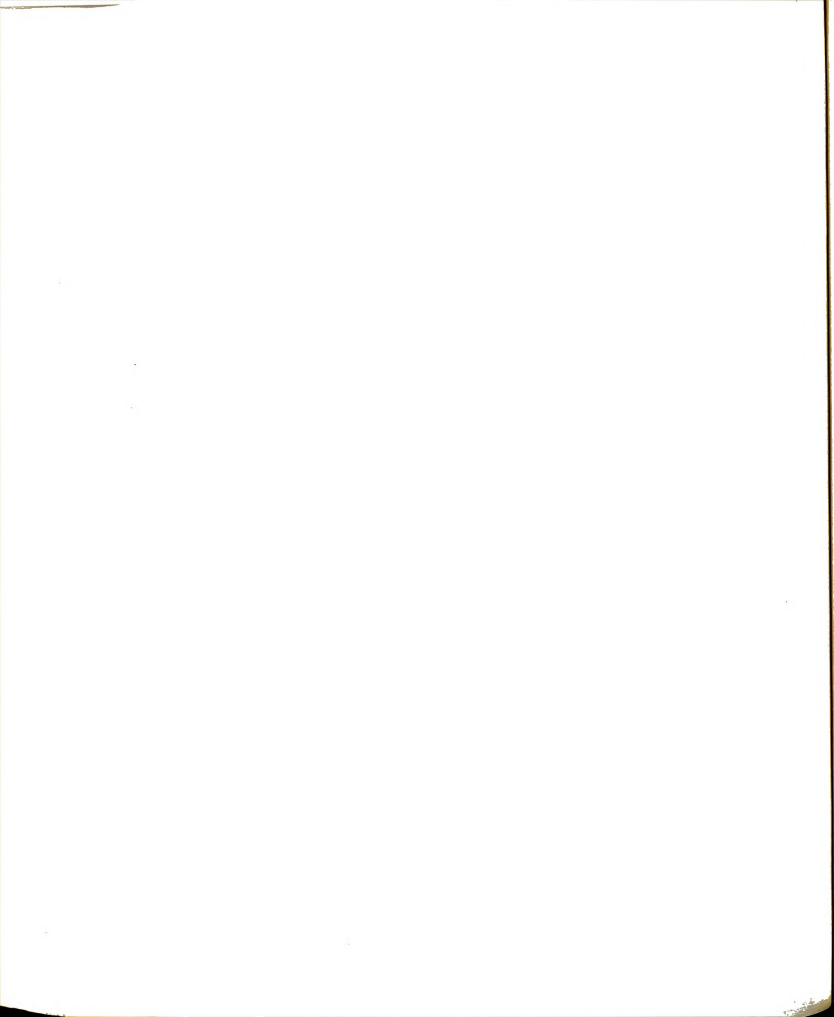
1. Failed to check for clutch free travel.	_____ x	10 _____
2. Failed to know how to check (at least 1 inch needed).	_____ x	10 _____

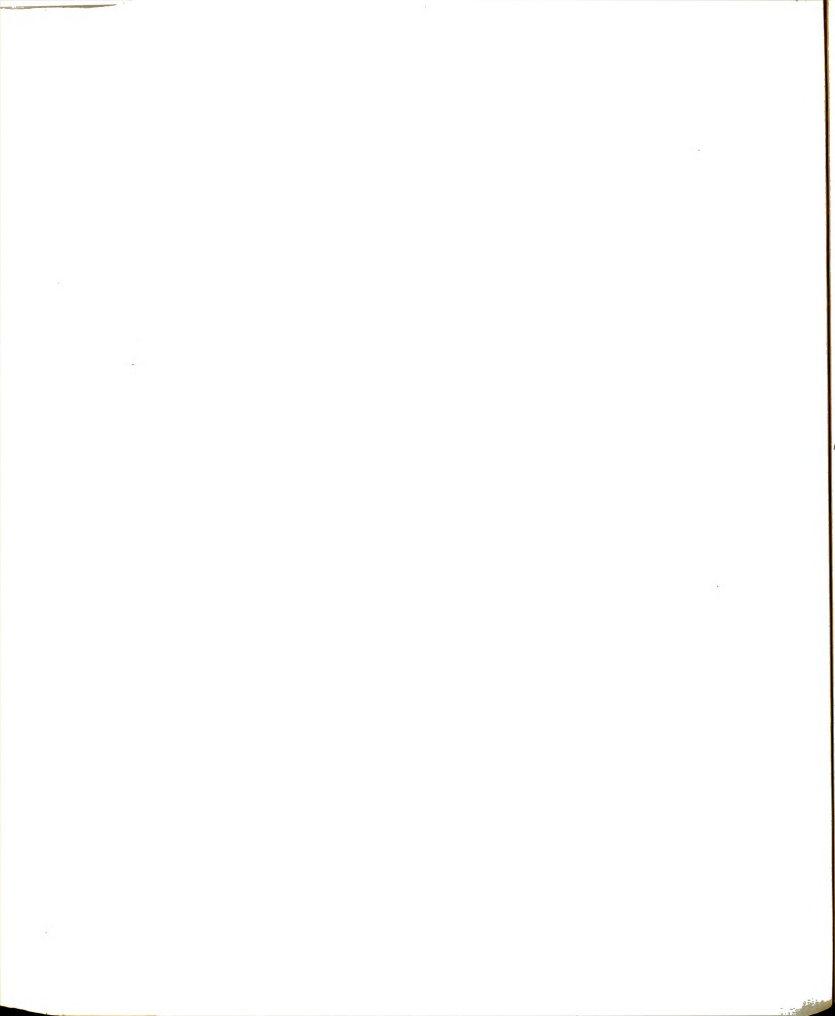
Tires and Wheels

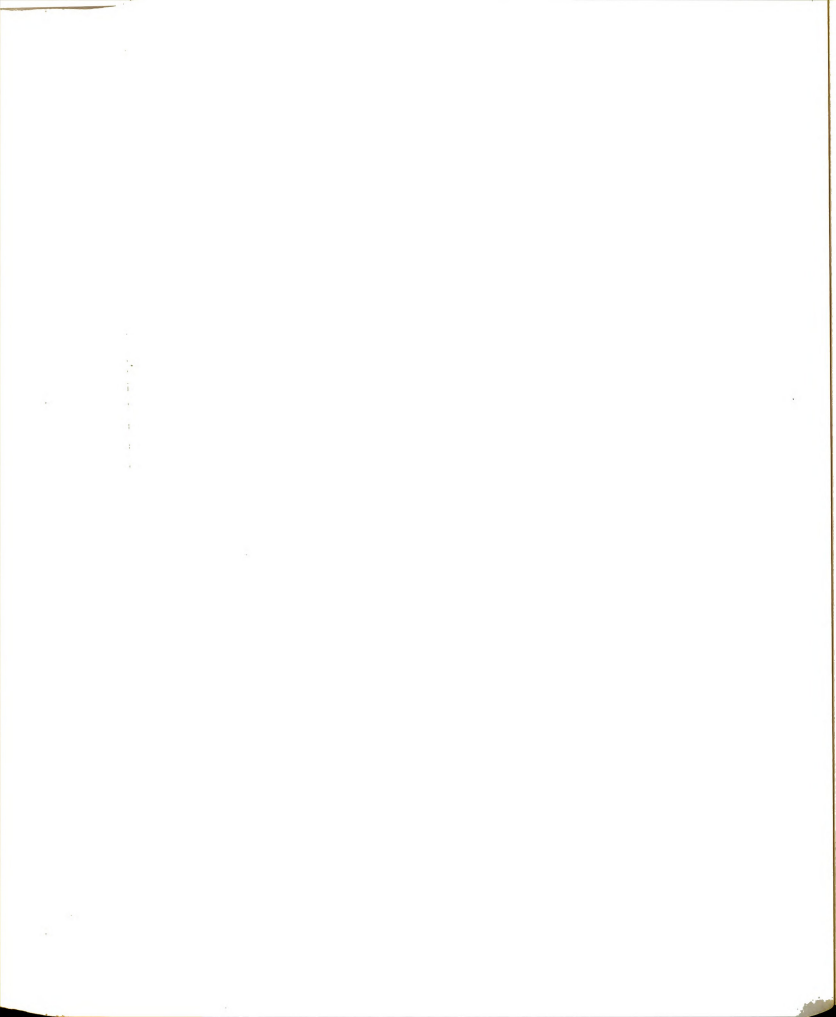
1. Failed to check air pressure in tires.	_____ x	20 _____
2. Failed to know correct pressure needed.	_____ x	10 _____
3. Failed to add or release air to correct pressure.	_____ x	10 _____
4. Failed to have valve stem at top when checking (for tires filled with water).	_____ x	10 _____
5. Failed to check wheel lug nuts.	_____ x	5 _____
6. Failed to find loose nuts and tighten.	_____ x	10 _____
7. Failed to find and report cuts, bulges in tires.	_____ x	10 _____

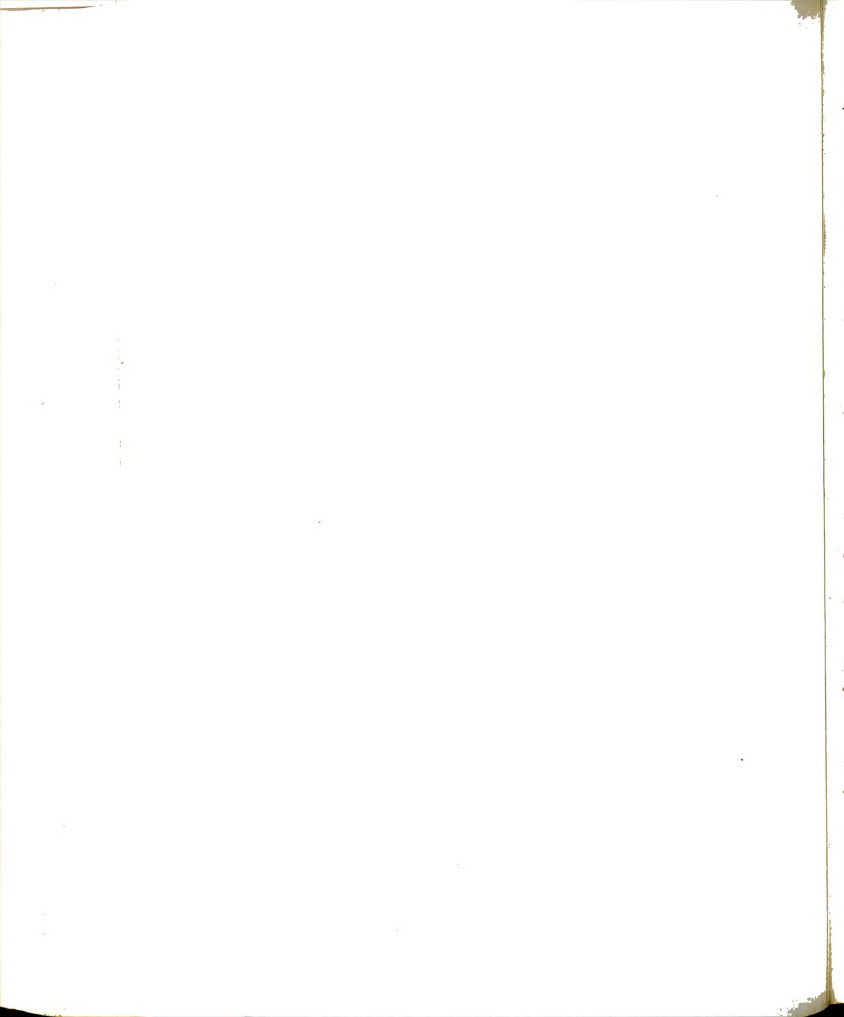
Dry Filter-type Air Cleaner

1. Failed to check dry-filter-type air cleaner.	_____ x	20 _____
2. Failed to check restriction indicator (if present).	_____ x	10 _____
3. Failed to check unloading valve.	_____ x	10 _____
4. Failed to remove filter and element and check.	_____ x	10 _____
5. Failed to clean dirty element correctly.	_____ x	10 _____
6. Failed to replace element correctly.	_____ x	10 _____
7. Failed to reset restriction indicator.	_____ x	10 _____









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