

AN ABSTRACT OF THE THESIS OF

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(Name) (Degree) (Major)

Education

Date thesis is presented May 10, 1965

Title THE PRINCIPLE APPROACH IN TEACHING MECHANICAL
TECHNOLOGY IN AGRICULTURE

Abstract approved Redacted for Privacy
(Major professor)

The agricultural industry is highly mechanized and the increased productivity realized from mechanization stimulates further and broader mechanical applications. Changing practices result in a "skill obsolescence" problem for those employed in the industry. This problem prompted the undertaking of a study to establish a broader base than manipulative skills for mechanical technology instruction in vocational agriculture programs to enable future employees in the agricultural industry to modify, adapt, improve, and increase their mechanical competence with changing conditions.

Related literature showed that while one of the purposes of education is to enable students to take an enlightened place in society, increasing dependence upon mechanization in conjunction with the rapid birth of new technical innovations makes it difficult for persons educated and trained by traditional methods to maintain the high degree

of skill flexibility needed to remain employed in technical occupations.

Subject matter specialists and teacher trainers at the university level and vocational agriculture teachers at the high school level cooperated with the investigator in identifying, classifying, and supplementing principles, or statements of generalized knowledge, applicable to Farm Buildings and Conveniences, one of the five generally accepted areas of mechanical technology instruction in vocational agriculture programs. The vocational agriculture teachers also subjected portions of the material to classroom trials.

Teachers interviewed after classroom trials felt that the principles and supporting information were valuable in teaching broad principles and concepts, tied in closely with broad considerations related to farm management, were organized favorably for inductive teaching, and reduced the amount of research, consolidation, and preparation necessary on their part. Similar studies in other areas of mechanical technology instruction were considered desirable for these reasons.

Findings should be subjected to broader studies to further verify the conclusions reached regarding their suitability for instructional purposes and efforts should be made to provide for more collaboration between subject matter specialists and vocational agriculture teachers in undertaking such studies.

THE PRINCIPLE APPROACH IN TEACHING
MECHANICAL TECHNOLOGY IN AGRICULTURE

by

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A THESIS

submitted to

OREGON STATE UNIVERSITY

in partial fulfillment of
the requirements for the
degree of

MASTER OF EDUCATION

June 1965

ACKNOWLEDGMENT

Thanks are due to Professor Henry A. Ten Pas and Professor Philip B. Davis of the Department of Agricultural Education who were instrumental in orienting, guiding, and advising the investigator in the undertaking and completion of this study and who, along with Professor L. V. Christensen, Department of Agricultural Engineering, Professor L. W. Bonnicksen, Department of Agricultural Engineering, and Professor E. N. Castle, Department of Agricultural Economics, participated in the initial review and revision of the technical material prepared by the investigator.

Vocational agriculture teachers Richard Buckovic, Molalla Union High School, Daniel Dunham, Drain High School, Burr Fancher, Woodburn High School, Gordon Galbreath, Wy'east High School, Curt Loewen and Cliff Green, Roseburg Senior High School, Monty Multanen, Dayton High School, Wright Noel, Bend High School, Joel Pynch, St. Paul High School, Henry Schmitt, Gervais High School, and Stanley Sisson, Nyssa High School have the investigator's heartfelt thanks for subjecting portions of the prepared material to a classroom trial and participating in a secondary review and revision.

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THE PRINCIPLE APPROACH IN TEACHING MECHANICAL TECHNOLOGY IN AGRICULTURE

I. INTRODUCTION

The significance of mechanization in agriculture was indelibly engraved upon the investigator's mind during extended stays in underdeveloped nations. In twenty-six months of observing subsistence agriculture in these nations, it was clearly realized that a transition from such primitive practices to an intensified, highly productive agricultural industry cannot be accomplished without mechanization. The major phases of such a transition have long since been accomplished in the United States. However, the increased productivity and efficiency resulting from this transition have served as continuing stimuli for further, broader, and more rapid mechanical advancement and refinement. This has resulted in a situation where many mechanical practices in agriculture change from year to year rather than from generation to generation. Instruction in mechanical technology, as a portion of the vocational agriculture curriculum, has been based largely upon specific skills. The situation described above makes the limitations of such instruction clear and suggests a need for an instructional approach which imparts generalized knowledge and provides broad frames of reference in addition to specific skills, thereby preparing students to cope more effectively with changing conditions.

Statement of the Problem

Vocational agriculture instruction in mechanical technology has consisted largely of teaching those specific manipulative skills and abilities which are essential for success in farming or closely related occupations at the time the instruction is offered. Students learn the skills well in most cases, but do not become sufficiently familiar with the underlying principles to be able to modify, adapt, increase, or improve their skills with changing needs. Furthermore, this lack of generalized knowledge makes it difficult for them to make wise decisions or sound plans for future conditions. "Knowing what" has been emphasized more than "knowing why". Rapid technical change in agriculture and our entire society as well demands that students be made sufficiently familiar with basic principles of mechanization to stay abreast of evolving trends.

Background

Persons planning to enter the agricultural industry today find there is a wide variety of occupations for which they can prepare. Just as the development of the industry has brought breadth to the farm-to-consumer process, so has it brought depth, diversity, and specialization to the echelons of employment. The production, processing, distributive, and marketing phases of the industry require

occupational specialties varying from common labor through supervisory and managerial positions to owner-operator statuses. Research, education, and extension work, examples of phases which contribute indirectly to the farm-to-consumer process, offer a comparable spectrum of occupations.

The direct and indirect aspects of the agricultural industry mentioned above have been referred to as phases in the farm-to-consumer process. This process might be more aptly called a system, with the phases being functionally interrelated organs working together toward a common goal. The implications of mechanical technology reverberate through the entire system, and while certain organs are less dependent upon mechanization than others, the high degree of interrelationship demands that all parts be conscious of it in furthering the aims of the whole. For similar reasons, persons filling the clusters of occupations offered in all phases of the industry must be conscious of the application of mechanical technology to agriculture and be able to cope with it in the manner called for by their occupational specialty.

Vocational agriculture instructors are charged with the task of preparing students to enter the agricultural industry. Ordinarily one third to one half of instruction is devoted to mechanical technology. Over the years the instructional task in mechanical technology has been complicated by the increasing variety of occupational specialties

in the industry, the more intense application of mechanization to the industry as a whole, and the dynamic nature of mechanical practices in agriculture. The first two factors suggest more specialization and more emphasis for mechanical technology in the vocational agriculture program. The third indicates the limitations of instruction which is based upon mechanical practices in effect during any one period. A paradoxical situation is thus indicated. Specialized occupations call for special skills or abilities in dealing with mechanical technology. The pressure of technical progress results in the rapid obsolescence of special skills and abilities and in some cases the entire occupational specialty. If a person is to survive and advance in the agricultural industry he apparently needs both special training and a general education. In so far as mechanical technology is involved in survival and advancement, it logically follows that an individual needs special skills or abilities plus a general framework or frame of reference which will ease the burden of adjusting to occupational changes calling for new skills and abilities and enable him to see more clearly the role of mechanical technology in agriculture.

Purpose of the Study

The purpose of this study is to identify, classify, and establish methods of teaching principles, or generalized bodies of knowledge, which apply to a limited portion of mechanical technology in

agriculture. It is based on the belief that such a body of information will remain valid and reliable over a period of time which will see many changes in specific skills and practices in this field. Therefore it will be valuable to vocational agriculture teachers as a basis for providing meaningful instruction and will reduce the necessity of frequent and extensive curriculum revision.

Limitations of the Study

This study is limited to Farm Buildings and Conveniences, one of the five generally accepted areas of instruction in mechanical technology in the vocational agriculture curriculum, and which is normally taught at the Junior and Senior level in high school. Findings are based upon literature pertinent to this field, professional knowledge and opinions of subject matter experts and educators at the university level, and suggestions and opinions of vocational agriculture teachers who reviewed and experimented with early versions of this material in the field. No statistical treatment was involved, and the findings were not tested as a part of this study.

Initial Assumptions

1. That there is a need for a broad foundation or framework upon which to base mechanical technology instruction in vocational agriculture programs.

2. That principles, or generalized knowledge, can serve as a basis for the formulation of a body of information which will function as a broad foundation for such instruction.
3. That subject matter specialists at the university level and vocational agriculture teachers at the secondary school level can contribute to the formulation of such a foundation or framework.
4. That this framework will be applicable in a wide variety of agricultural, economic, climatic, and geographical conditions.
5. That this framework will remain useful over a period of time which will see a great many changes in specific mechanical practices in agriculture.

Definition of Terms

Mechanical Technology in Agriculture -- A term used to designate the segment of vocational agriculture instruction devoted to Farm Shop, Farm Power and Machinery, Rural Electrification, Soil and Water Management, and Farm Buildings and Conveniences. Used synonymously with Farm Mechanics or Agricultural Mechanics.

Principle -- a generalization based on facts and on elements of similarity common to a number of situations.

Subject Matter Specialist -- A member of a college or university

faculty or research staff who has concentrated his efforts in a specific segment of a particular discipline and possesses expert knowledge on matters pertaining to his specialty.

Subsistence Agriculture -- Primitive farming typical of under-developed countries. Characterized by low productivity per farm or farmer, lack of mechanization and a subsequent high labor requirement, little or no processing of products marketed, and income sufficient to provide for only the most basic physiological needs.

Teacher Trainer -- A qualified professional person responsible for the preparation and in-service training of teachers. He assists teachers or prospective teachers to secure the professional knowledge, ability, understanding, and appreciation which will enable them to meet certification requirements or advance in teaching positions.

The Agricultural Industry -- The vast array of organized activities directly and indirectly associated with the production, processing, distribution, and marketing of food and fiber produced on farms.

Vocational Agriculture -- A systematic program of instruction conducted under the Smith-Hughes and George-Barden Acts for public school enrollees, out-of-school and post-high school youth, and established farmers, organized for the purpose of improving agricultural methods and rural living.

Vocational Agriculture Teacher -- A teacher who has had special training and preparation in scientific agriculture and administers the

vocational agriculture program.

Procedure

Upon returning from a stay of more than two years in under-developed nations and enrolling at Oregon State University, the investigator was introduced to the principle approach concept and the recent work done to use this approach in vocational agriculture instruction. A special interest in instruction in mechanical technology resulted in a desire to undertake a study involving the principle approach in teaching mechanical technology in agriculture. Time limitations made it necessary to restrict this study to one of the five areas in mechanical technology instruction. A course taken during the first quarter of matriculation at Oregon State University was largely based upon broad principles and concepts involved in farm building planning, building systems and services, economic considerations, and so forth. The knowledge imparted to the investigator through this course as well as the acquaintance established with the instructor and his instructional approach made it convenient to choose the area of Farm Buildings and Conveniences for the study.

Early in the planning stages of this study the desirability of involving vocational agriculture teachers in the revision and refinement of the material developed was established. A conference with staff members of the Agricultural Education Department resulted in a list

of teachers who had exhibited promising work as vocational agriculture teachers in general, were familiar with the principle approach concept, and were considered likely to be willing to cooperate in a study of mechanical technology instruction. These teachers were contacted personally by the investigator and eleven teachers agreed to cooperate by making their opinions, suggestions, and criticisms available for use in revision and refinement of material prepared during the course of the study, and also by trying portions of the material with their classes.

The investigator then prepared a tentative set of principles, sub-principles, and supporting information on Farm Buildings and Conveniences based upon his own personal knowledge of the field and a review of pertinent literature. The next step was to subject this material to a critical review by subject matter experts and education specialists from the faculty of Oregon State University. Involved in this review were two professors of Education who are also teacher trainers, two professors of Agricultural Engineering, one whose field is mechanical technology instruction and the other being a farm building specialist, and one professor of Agricultural Economics.

Certain revisions were made in this material following this review and copies of the revised material were sent to the vocational agriculture teachers previously contacted. Additional visits and correspondence with these teachers after receipt of the material resulted

in a determination of what portions would be tried experimentally with their classes. After sufficient time for review and trial had elapsed, copies of an interview check list were sent to the cooperating teachers to familiarize them with the characteristics of a pending interview. Personal interviews to gather their reactions and suggestions were subsequently conducted and recorded on tape. A final revision of the material was based upon the information gathered during the interviews.

II. SURVEY OF RELATED LITERATURE

Curriculum Reform

A study dealing with the nature and content of material used as a basis for instruction in public schools and the methods employed in utilizing it might well be prefaced with a brief examination of the fundamental purposes of formal education and the philosophy which underlies it. Such an examination will perhaps free us momentarily from exclusive concern with present educational problems and allow us to develop a broad view or perspective from which we can in turn proceed to the specific problems of today. Benjamin (3, p. 28-30), in his amusing but unpretending account of paleolithic education, tells of the beginnings of formal education and curriculum development.

Having set up an educational goal, New-Fist proceeded to construct a curriculum for reaching that goal. "What things must we tribesmen know how to do in order to live with full bellies, warm backs, and minds free from fear?" he asked himself. To answer this question, he ran various activities over in his mind. "We have to catch fish with our bare hands in the pool far up the creek beyond that big bend," he said to himself. "We have to catch fish with our bare hands in the pool right at the bend. We have to catch them in the same way in the pool just this side of the bend. And so we catch them in the next pool and the next and the next. Always we catch them with our bare hands."

Thus New-Fist discovered the first subject of the first curriculum -- fish-grabbing-with-the-bare-hands.

"Also we club the little woolly horses," he continued with his analysis. "We club them along the bank of the creek where they come down to drink. We club them in the thickets

where they lie down to sleep. We club them in the upland meadow where they graze. Wherever we find them we club them. "

So woolly-horse-clubbing was seen to be the second main subject in the curriculum.

"And finally, we drive away the saber-tooth tigers with fire," New-Fist went on in his thinking. "We drive them from the mouths of our caves with fire. We drive them from our trail with burning branches. We wave firebrands to drive them from our drinking hole. Always we have to drive them away, and always we drive them with fire. "

Thus was discovered the third subject -- saber-tooth-tiger-scaring-with-fire.

Having developed a curriculum, New-Fist took his children with him as he went about his activities. He gave them an opportunity to practice these three subjects. The children liked to learn. It was more fun for them to engage in these purposeful activities than to play with colored stones just for the fun of it. They learned the new activities well, and so the educational system was a success.

However in the paleolithic era conditions changed as time passed on. An ice age brought about climatic variations which saw the streams become so muddy that fish could no longer be grabbed with the bare hands. Also, the horses and tigers were replaced with antelopes and bears respectively. Thus fish netting, antelope snaring, and bear-pit digging became the activities necessary for survival. It was inevitable that these activities be considered for inclusion in the paleolithic school. Benjamin (3, p. 43-44) tells of the argument which subsequently arose between the Traditionalists and the Progressivists on this issue.

"But-- but anyway," he suggested, "you will have to admit that times have changed. Couldn't you please try these other more up-to-date activities? Maybe they have some educational value after all?"

Even the man's fellow radicals felt that this was going a little too far.

The wise old men were indignant. Their kindly smiles faded. "If you had any education yourself," they said severely, "you would know that the essence of true education is timelessness. It is something that endures through changing conditions like a solid rock standing squarely and firmly in the middle of a raging torrent. You must know that there are some eternal verities, and the saber-tooth curriculum is one of them.

While the above argument has far-reaching implications which perhaps still have not been resolved, it is quoted here to bring the following points to light:

1. The purpose of formal education is to endow the youth of a society with the skills, abilities, and competencies necessary to survive and participate in that society.
2. Environmental, technical, and social conditions change with the passage of time and the process of formal education must take these changes into consideration if it is to accomplish its purpose.
3. While the existence of "eternal verities" may be questioned, there are doubtless certain values, principles, and guidelines which, though not eternal, are valid over a broad period of man's development and their usefulness will and does transcend the particular period wherein they were developed.

Perry (9, p. 411) takes all these factors into consideration in explaining the purpose of education.

In the fundamental sense, education is the cultural process by which successive generations of men take their places in history. Nature has assigned an indispensable role to education through the prolongation of human infancy, and through the plasticity of human faculties. By nature man is not equipped for life but with capacities that enable him to learn how to live. Since it is generally agreed that acquired characteristics are not inherited education assumes the full burden of bringing men "up to date," creating "the modern man" of the 1953, or any other latest, model. Through education men acquire the civilization of the past, and are enabled both to take part in the civilization of the present, and make the civilization of the future. In short, the purpose of education is three fold: inheritance, participation, and contribution.

Smith, Stanley, and Shores (10, p. 1-2) make the role of the school clear in relation to this three-fold purpose.

The relations between school and society are important enough in a period of relatively little social change. In a time of profound social change, the relationship is even more important because society is then not all of one piece. Old and new social elements are to be found side by side -- and frequently in competition with one another for survival. In such a period the school tends to reflect the older elements of society. The teaching profession needs to be on guard at such a time against making the school a repository of out-worn ideas, ideals, and skills. It then becomes the task of the teaching profession to keep the schools up-to-date, and, when possible, to shape the educational program in such a way as to influence the form and direction of social development.

While change has been a constant in the development of the human race, the rate of change in the past few decades has increased tremendously. If change could be visualized as taking place in steps, then each step seems to lead to another step which dwarfs the one

preceding it, so that the rate of change is geometric rather than arithmetic. As a result profound changes, rather than spanning several generations as in the past, severally occur within a single generation, or even within a decade. The social implications of such rapid change are explained quite clearly by Smith, Stanley, and Shores (10, p. 51).

The displacement of workers is one of the tragic results of technological developments. By better management and more efficient machines, technological innovations may displace workers directly, or they may displace them indirectly in ways too numerous to mention here. For an example of direct displacement, the development of a higher quality of steel for machine tools made it possible to operate machines at a higher speed and reduced the amount of sharpening ordinarily required. The result was a reduction of the labor needs of the industries using these tools.

A displaced worker does not easily find re-employment. If he is fortunate, he may find a job in the occupation for which he is trained and at a wage equal to that of his former job. The fortunate individual is, unhappily, the exception. The more likely outcome is weeks and months of job-hunting and finally employment at a lower wage and in a less promising position.

While change in our society was depicted in a preceding paragraph as taking place in steps, this was done merely to simplify the explanation of the rate of change. In reality change in recent years has proceeded in a fashion more comparable to that of a body falling under the acceleration of gravity, or a snow ball rolling down a slope, gathering more material as it gathers speed. Unfortunately it is curriculum change that is more readily illustrated by the "steps"

analogy and which seems to jump from plateau to plateau, each jump becoming larger in a vain effort to overtake societal change; the latter escalating more smoothly upward at an ever-increasing rate. Those responsible for curriculum revision are often prodded, rightly or wrongly, into leaping to the next plateau only by sudden events of world-wide significance. Consider the statement of Goodlad (5, p. 9) about curriculum change.

The beginnings of the current curriculum reform movement are commonly identified with the successful launching of the first Russian satellite in the Fall of 1957. This spectacular event set off blasts of charges and countercharges regarding the effectiveness of our schools and accelerated curriculum revision, notably in mathematics and the physical sciences. But the roots go back further, to the years immediately following World War II. The recruitment of young men for the armed services had revealed shocking inadequacies in graduates. The problem was partly the limited quantity of work in these fields, partly the quality of what had been taught. The secondary-school curriculum too often reflected knowledge of another era, instead of the scientific advances of the twentieth century. Recognizing their responsibility for this unhappy state of affairs, scholars in a few fields began to participate actively in what has now become a major curriculum reform movement.

Vocational and Technical Education

Vocational and technical education are concerned with the provision of training intended to prepare the student to earn a living in an occupation in which success is dependent largely upon technical information and an understanding of the laws of science and technology as applied to modern design, production, distribution, and service

(2, p. 22). The trend in our society toward increased dependence upon mechanization and material things in recent decades in conjunction with the rapid birth of new technological innovations and more sophisticated production techniques has made the shortcomings of vocational and technical education painfully evident and has resulted in a very real societal problem. Smith, Stanley, and Shores (10, p. 52) express this problem in the following way.

With dislocation of workers due to sweeping industrial changes, or with displacements due to technological innovations in specific industries or establishments, the significance for the worker is apt to be the same in many instances --namely, "skill obsolescence". The rise and fall of industries and occupations places upon the worker a tremendous burden of uncertainty, readjustment, and re-education. When an industry is completely eliminated, when a new process of making a product is employed, or when engineering achievements replace old machines, the worker who is thereby displaced is called upon to develop new skills if he is to find employment. Moreover, the introduction of laborsaving devices such as calculating machines, dictaphones, bookkeeping machines, and the like, requires new skills and techniques among office workers. In the modern industrial system the worker is called upon to maintain a higher degree of flexibility in the skills by which he earns a living than in any other period of recorded history.

The problem brought out above is perhaps not as earth-shaking as a world war or the launching of a satellite, but careful consideration would show that its significance in relation to society and its survival might be just as great. It is no wonder, therefore, that concern over the inadequacies of vocational and technical education is being expressed by leaders in this field. To cite just one example,

Wesley P. Smith (11, p. 16), State Director of Vocational Education in California, in writing of the current interest in vocational education at all levels of government, industry, private organizations, and the society as a whole, says the following:

This wide spread and growing interest in vocational education, although extraordinary, is easily explained. It results from the shock waves of major change in modern society. It is influenced by the knowledge that the economic vigor and the productive strength of our country depend increasingly upon the occupational competence of every person. It is the inevitable consequence of deficiency in the schools in meeting the genuine educational needs of all students. It is recognition of urgent demands for all workers to have the capabilities to endure in, and take advantage of, the technological environment of this age.

As skill requirements in all occupations continue their upward spiral, as competition for all jobs becomes more severe, as the high unemployment rate for youth perseveres, and as the choice of, the preparation for, and entrance upon careers become more and more complicated, it is no wonder that there exists almost universal anxiety regarding the manner in which high schools are contributing to the occupational intelligence of youth.

A few months after the preceding words were written, a long-standing concern over vocational education on the part of the Federal Government was culminated in the passage of Public Law 88-210 (2, p. 22-23), enacted:

to authorize federal grants to states to assist them to maintain, extend, and improve existing programs of vocational education, to develop new programs of vocational education, and to provide part-time employment for youths who need the earnings from such employment to continue their vocational training on a full-time basis, so that persons of all ages in all communities of the states -- those in high school, those who have completed or discontinued their formal

education and are preparing to enter the labor market, those who have already entered the labor market but need to upgrade their skills or learn new ones, and those with special educational handicaps -- will have ready access to vocational training or retraining which is of high quality, which is realistic in the light of actual or anticipated opportunities for gainful employment, and which is suited to their needs, interests, and ability to benefit from such training.

Vocational Agriculture Education

Turning now to vocational agriculture and mechanical technology, that portion of vocational education with which this paper is concerned, a bulletin published by the U. S. Office of Education (6, p. 1-3) summarizes the history of mechanization and technical innovations in agriculture.

In colonial days 85 percent of our people gained their living from working the soil. Today, with the per capita consumption of farm products much higher, the rural farm population of 7.5 percent produce an abundance of many food and fiber items. This increased productivity per farm worker is a result of improved agricultural technology, including mechanization on the larger farms. Today agriculture is a big business. During World War I each farm worker had an average of 5 horsepower at his command, while at present it approaches 50 horsepower. During this same period the productivity per worker has more than quadrupled and now an average farm worker provides food and fiber for 27 persons.

Today, with fewer farmers on the land, there is a compensating increase of workers employed in agricultural occupations, other than in farming. The farm boy, with his experience of rural life and work on the farm, has a distinct advantage for gainful employment in the broad field of agriculture. Unlimited opportunities exist in most localities for agriculturists to serve as custom operators who apply lime, insecticides, pesticides, fumigants, and fertilizers; processors of dairy products, animal feeds, and meats;

constructors of irrigation ditches, drainage ditches, terraces, and farm reservoirs; and assistants in the marketing, transportation, and distribution of farm produce. Other jobs would include gardening and landscaping to meet the needs of home owners, business firms, and highway departments. Nearly all of these agricultural occupations require evidenced experience in one or more areas of farm mechanics.

In the next decade those who operate the land will have a greater dependence on power farming -- both motor and electric. Much of the power equipment will be farmer-owned and may be operated by him or by hired operators. There will be a continuing need for an adequate program to train high school farm youth, young farmers, and adult farmers in the selection, operation, proper use, and maintenance of farm tools, machinery, and other mechanical equipment. There will be a continuing need to keep farmers advised of new types of farm machines and equipment and for training in their use. In some cases equipment will be rented for special jobs and some jobs will be contracted. Types of jobs that may be contracted are terracing, land leveling, ditching, dam construction, sewage system installation, logging, rock removal, tiling, plowing, spraying pesticide and herbicide chemicals, processing, and harvesting.

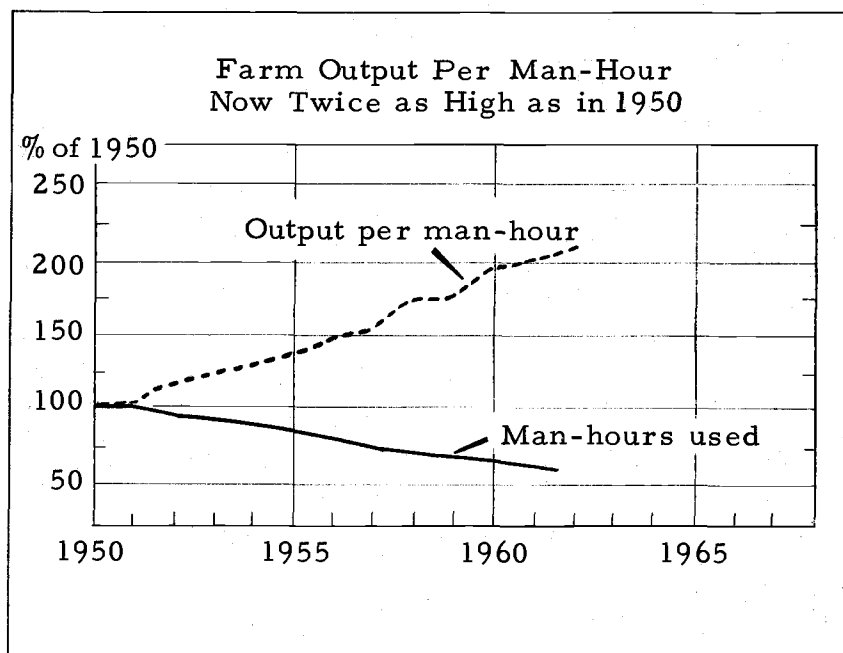
Until World War II the mechanical instruction in vocational agriculture was mainly in the area of farm shop work. Today the program has been expanded to meet the needs of mechanized agriculture. Training involves five areas -- farm power and machinery, soil and water management, farm buildings and conveniences, farm electrification, and farm shop work.

A specific example from only one of the five areas listed previously as areas of mechanical technology instruction is a good illustration of how much we depend upon mechanization in agriculture today (6, p. 4).

The last United States census report shows a production of 3,697,190,984 bushels of corn. A man husking corn by hand in a field yielding 100 bushels per acre would do well to husk 100 bushels per day. It would require approximately 474,000 men working at the same rate throughout the months of October, November, and December to harvest the nation's

corn crop. The task of hand harvesting has been practically replaced by the easier and faster mechanical method. The 1960 census reports 792,379 mechanical corn pickers on our farms.

Even the last 15 years have seen no leveling out of mechanical applications to agriculture but on the contrary have seen productivity per man hour continue to increase, largely by virtue of mechanization, as illustrated by the graph below (6, p. 1).



This evidence on the rapid increase, constant change, and broadening significance of mechanization in the agricultural industry has

been cited to support the contention that problems in vocational agriculture mechanical technology instruction can be expected to parallel those previously cited in vocational education as a whole and in general education as well. The "shock waves of major change" mentioned by Mr. Smith certainly have not bypassed this field. As would be expected, therefore, periodical literature is filled with articles on problems, shortcomings, and recommendations for improvements in mechanical technology instruction. While recommendations vary widely, a number of persons have recognized the futility of basing instruction entirely upon skills and practices in effect at any one time. The problem is not only that of skill obsolescence but also that of continual and extensive curriculum revision. Therefore, while the importance of skills is recognized by the authors quoted below, the teaching of principles or generalized truths which are valid and reliable over a long period of time is advocated, the idea being that this will result in basic understandings which will reduce the problem of adapting to changing practices. Albrecht (1, p. 195-196) touches briefly upon this problem as follows:

The increasing complexity of our farm power units, machines, materials handling systems, processing equipment, and the like, calls for more expert work by specially trained personnel in the areas of major repair, systems planning and installation. This means that more agricultural mechanics work will be contracted for, but it also means that the farmer must be conversant with the new problems arising.

Therefore, in our teacher education programs we must increase

our emphasis on principles involved in Agricultural Mechanics and on the managerial aspects of it.

In recommending how actual work in the school farm shop should be supplemented, Wooden (13, p. 195-196) states:

The first supplement should be given in the classroom. As students are taught more complex aspects of farm mechanics including electrification, welding, and tractor maintenance, for example, the shop demonstration while still important does not provide sufficient depth of understanding. Classroom discussion and supervised study of underlying principles becomes more and more important.

In dealing specifically with the problem of teaching farm machinery, Marvin (8, p. 205-207) writes:

Early farm machinery developments often were crude and haphazard, with the cut-and-try system predominating. Present-day farm machinery design, however, is more scientific and the development of a machine is based increasingly upon fundamental principles and information obtained by research.

The first experimental designs of new machines are primarily functional and generally deal with machine elements rather than complete machines, the chief objective being to test and develop (or discard) certain ideas or principles of operation.

A study of the principles of operation would seem to be a sound psychological approach to learning the operation, maintenance, repair, and adjustment of farm machinery. Machine design may change in the method of incorporating the principle, but the principle will remain the same and appear repeatedly in different machines.

Johnson (7, p. 198-199) though speaking of preparation of future vocational agriculture teachers, raises some good points in the following:

We need to review our objectives for the undergraduate

curriculum and rewrite the objectives to fit the emerging concepts of vocational education in agriculture. We have a heritage unique in education involving science with practice, whereas in the past we perhaps have overemphasized the practice and taught our students too much of the "know-what" and not enough of the "know-why". The inherent potential of the basic concept of vocational education in agriculture provides us with a unique opportunity to use science to elucidate the "know-why". The "know-what" often changes, but the basic principles of the "know-why", if they be basic principles, are unchanging.

As if in answer to general concern being expressed in the field and the specific desires expressed in the preceding quotes, the U. S. Office of Education has recently published a bulletin entitled, "Instruction in Farm Mechanics". Even a brief examination of the general objectives set forth in this bulletin and reproduced below (6, p. 14) will make it clear that instruction based upon skills alone will not enable students to meet these objectives.

General Objectives

1. To develop an understanding and appreciation of the physical and mechanical aspects of farming, and the importance of farm mechanics to farming as a whole.
2. To develop skills and abilities sufficient to assist with and perform the more technical problems of the farm operator which involve engineering applications.
3. To develop abilities sufficient to perform the common and important operations or processes involving the selection, care, and use of tools, machinery, and mechanical equipment.
4. To develop the ability to make sound farm management decisions in each of the five areas of farm mechanics.
5. To develop the ability to plan, organize, and equip a school

farm mechanics shop and a home farm shop.

The teacher's overall goal is to develop understandings of basic principles involved as well as judgment and ability in the areas taught.

Furthermore, considering some of the specific objectives stated in this bulletin regarding instruction in the five areas of mechanical technology, it is implicit that principles from the fields of economics, mathematics, physics, geometry and others must be drawn upon.

For instance, the first two objectives in Farm Power and Machinery instruction are (6, p. 14):

Develop ability to:

1. Recognize and identify the fundamental principles involved in machines and the relationship of mechanisms and systems to processes and functions.
2. Select power units and machines with regard to cost, to adapting systems of machines to types of farming, and to coordinating individual machines with other components of the machinery system; consider size and number of power units, hours of utilization, annual cost, and availability and cost of dealer service and custom rental.

The following objective of instruction in Farm Buildings and Conveniences shows the need for a similar reliance on such principles (6, p. 17).

Develop ability to:

1. Lay out a farmstead and plan a coordinated farm improvement program; evaluate existing buildings; analyze the need for new or reconditioned structures; plan new buildings; develop a maintenance and improvement program recognizing basic requirements for farm structures.

The term "principle" is used often in the material quoted in the previous paragraphs, but little evidence is found in these or other sources that efforts have been made to identify, classify, and establish methods of teaching these principles which are deemed to be so important to effective instruction. Indeed, few if any authors even define the term! The investigator was able to find only two studies which dealt comprehensively with determining principles applicable to a field of instruction and organizing them in such a way that they would serve as a basis for instruction. While both dealt with principles applicable to vocational agriculture instruction, neither was concerned specifically with the field of mechanical technology.

The first study (12) cited was conducted in California with financial assistance from the National Defense Education Act. A principle was defined in this study as (12, p. 2):

a fundamental truth, a law of conduct that has general applications and is a basis for action. It is a generalization based on facts and on elements of "likeness" common to a number of situations. Since a principle is a generalization, there are sometimes minor exceptions to it, but it still has general application. One can generalize that the modern basketball player should be well over six feet tall although many shorter men develop into star players.

This study (12) was conducted in a number of identifiable steps. First a vocational agriculture teacher, a biology teacher, and a candidate for a Ph. D. in Plant Physiology developed a set of biological principles applicable to agriculture. The second step was to subject

this material to a critical review by members of the faculty and research staff of the University of California at Davis. The completed material was then evaluated by a panel of teachers of high school and junior college agriculture, state college and university instructors, and state specialists and consultants in biology and education. The last step was a series of experimental trials and further refinement of the resulting twenty two biological principles in a number of vocational agriculture departments. The principles were supported by definitions, important facts, and suggested teaching procedures.

The second study (4) was conducted at Oregon State University and involved the principle approach to teaching plant science. The investigator in this study became interested in the principle approach as a result of certain course work toward his Master's degree and was involved in the organization and development of a core unit in soils and plant nutrition which used this approach. Later a committee of subject matter specialists from the staff of Oregon State University was organized to assist the investigator in developing principles basic to the area of plant science. This committee was of assistance in the limitation, authentication, and organization of principles, sub-principles, and supporting information. The material developed was not tested as a part of the study.

If instruction in vocational education and vocational agriculture

is to be based even in part upon principles, it appears that much work remains to be done in the way of identifying them.

III. FINDINGS

A Resource Unit for Teaching Farm Buildings and Conveniences

This material is divided into three sections. Each section begins with a main principle. A number of sub-principles follow, with supporting information and suggestions for teaching. A fourth section suggests some unifying exercises or activities which may be used at the end of a unit of instruction based upon this material.

The material is organized and presented according to the following pattern:

1. Principle

A. Sub-principle

- I. Supporting Information -- Factual material, illustrations, definitions, and general information which support the sub-principle and, indirectly, the main principle.

Suggestions for Teaching.

Functional Principles

1. Farm buildings and conveniences vary according to the purpose for which they are intended. There is a wide variety of purposes for which they are used, thence a correspondingly wide variety of functions they perform.

A. Farm buildings and conveniences are put to either a consumptive use or a productive use.

1. Consumptive use buildings provide certain necessities, comforts, and luxuries for the farm family, the tenant farmer, or hired labor, and do not contribute directly to agricultural production.

Consumptive use buildings

Farm homes

Tenant homes

Bunk houses

Mess halls

Workers' homes

Consumptive use conveniences

Plumbing and water systems

Sewage disposal systems

Productive use buildings and conveniences are used in connection with crop or livestock enterprises and contribute directly to agricultural production.

Productive use buildings

Animal shelters

Dairy barns

Poultry houses

Hog houses

Beef cattle barns

Sheep barns

Crop processing

Silos

Grinding and cleaning buildings

Seed houses

Packing sheds

Crop storage

Hay barns

Grain bins

Silos

Corn cribs

Potato cellars

Fruit storage warehouses

Equipment facilities

Machinery sheds

Tractor sheds

Repair shops

Fuel storage

Water supply and sanitation

Water towers

Reservoirs

Septic tanks

Pump houses

Miscellaneous

Fences and gates

Paved areas

Cattle guards

Loading chutes

Bridges

Erosion structures

Suggestions for teaching

1. Have students individually or in groups list as many types of farm buildings as they can think of. Then use the blackboard to classify the buildings and conveniences according to use, i. e. , animal shelters, crop storage, and so on. Point out the broad division between consumptive use and productive use buildings and how they are defined.
2. Make a field trip to a farm with a high degree of building services. Have students compile a list of all buildings and conveniences they see and determine the purposes for which they are used. Back in the classroom, set up a scheme for classifying the buildings and conveniences they have listed and make

additions to their lists as necessary. Students just beginning a study of Farm Buildings and Conveniences will probably omit items like farm houses, paved areas, bridges, and fences. Show that certain of these categories contribute directly to production, others, like farm houses and mess halls, contribute indirectly but are just as important when the farmer is considering how best to invest.

3. Choose a farm enterprise which is common to the area and ask students to name buildings and conveniences which are essential for it. Lead them to name the less obvious necessities, such as fences, water systems, repair shops, and so on. List them on the board and establish categories as they come up. Do the same with several other enterprises, until a fairly complete list has been compiled. Point out that some are directly connected with production and some indirectly connected.

B. Farm buildings and conveniences control or exclude environmental forces which are detrimental to farm operations, resulting in more comfortable, more convenient, and/or more profitable farm operation.

1. Buildings control or exclude the following environmental

forces:

Weather -- sun, wind, temperature, humidity, precipitation.

Unwanted living organisms -- predators, insects, rodents, disease and rot causing organisms.

Unwanted non-living matter -- dust, smoke, gases, odors.

Unlawfulness -- trespassing, vandalism, burglary.

Internal forces -- buildings used for storage, such as silos, hay barns, and water towers, are subjected to pressures resulting from the weight of their contents.

External forces -- Loads may vary from dead loads, resulting from the weight of building components, to loads of several months, resulting from snow, to loads of one day or less, with a severe wind, to loads of very short duration resulting from tornadoes, wind gusts, or earthquakes.

Suggestions for teaching

1. Ask student why human beings find it necessary to live in houses. What are some of the services a house provides. How would housing requirements differ between Africa and Alaska or between Eastern Oregon and Western Oregon. The various ways in which a house provides protection from environmental

elements can be related to similar services performed by buildings and conveniences.

2. Ask students if they can imagine a situation where farming could be carried on without any buildings or conveniences. (Certain grazing operations in some parts of the world can operate in this way.) Consider the various aspects of a dairy operation, for example. Would the creamery buy your milk if the cows were milked out in the pasture? Could you make silage without some sort of building or convenience? Could you find your cows when it was time to milk them? The various aspects of environmental forces and their control can be brought out by systematically going through the various operations in one or more farm enterprises.

C. Farm buildings and conveniences provide systems of arrangement and apportionment of space and building components which contribute to the overall efficiency of farm operations.

1. A building must provide a space of the proper size and shape to make it possible to carry on the operation for which it was intended.

Walls, doors, ceilings, roofs, windows, and accessory

equipment are building components which are combined to form a space of the proper size and shape.

Arrangement is the combination of building components and space to form a building unit.

Apportionment is the assignment of a part of the building for a certain use.

Good arrangement and apportionment results in better building utilization -- less labor, less moving of materials, and less restriction on movement of material.

Suggestions for teaching

1. Make a field trip to observe both an old and a more modern milking facility. Study the arrangement and apportionment of building components and internal facilities with particular regard for the reduction of labor, ease of material handling, and convenience in feeding, watering, and maintaining sanitary conditions, as well as flexibility for future changes. Compare the two systems on this basis and suggest some modifications which might be made.
2. Make a list of the major pieces of machinery on a highly mechanized farm. Determine the size and

shape of the space needed for storage for each piece and cut out pieces of cardboard proportional to this size and shape. Use these pieces to try different arrangements of storage and to determine what type of building might be suitable. Judge the arrangements according to flexibility, ease of handling, and so forth. (This could serve as an introduction for a creative planning project that might be used later.)

3. Use the vocational agriculture shop to point out certain arrangements and apportionments which the students have taken for granted since they started high school. Tell of changes which were made over the years and what changes are contemplated for the future. Point out obstacles which arise from the size and shape of the building and the position of some of its components.

D. The attractive appearance displayed by farm buildings and conveniences serve indirectly to assist the farmer in profitable operations.

1. An attractive appearance is desirable for pride of ownership and esthetic values, but also because it contributes indirectly to agricultural production by helping attract customers and leaving a good impression on people with

whom a farmer deals.

Suggestions for teaching

1. Make a comparison between a farmstead and a salesman who calls at your door. If the salesman is sloppily dressed, unshaven, and unable to express himself adequately, he will not be likely to make a sale, even though the product he is selling is a good one. If he came to your door asking to borrow money, the same factors would be important in reaching a decision. An attractive appearance has an indirect bearing on many business transactions carried on by a farmer.
 2. Ask students why you (the vocational agriculture teacher) insist upon good workmanship on the shop when, for example, a sloppily built hay rack would probably function just as good as a neatly built one. Similarly, why do you insist upon keeping your shop and classroom reasonably neat and orderly. The business relationship between taxpayers and the school can be compared to that between the farmer and the people he does business with.
- E. The total service needs of one or more farm enterprises are provided by various individual buildings whose individual

services complement each other in working toward a common goal.

1. A system is a set or arrangement of things or processes so involved as to work together toward a common goal.

Buildings which work together toward a common goal are known as a building system. A building system for a dairy enterprise, for example, would provide all the services needed for calving, feeding and watering, milk production, marketing of dairy products, veterinary treatment, and so forth.

Suggestions for teaching

1. Use one of the systems in an animal's body to get this principle across. The digestive system, for example, would seem rather simple at first, consisting of perhaps the mouth, esophagus, stomach, and intestines, but further investigation would bring out the importance of kidneys, liver, enzymes, and so on, all working toward a common goal of extracting energy from food. An additional step could be to compare the manner in which other body systems dovetail in with the digestive system to the way in which building systems on a farmstead work together.

2. Write down "barley seed" on one end of the board and "meat, milk, eggs, or wool" on the other. Show a number of paths or processes by which the barley seed can be converted to a marketable product. As the paths are marked out, bring out the need for building services along the way, and show how they form a building system by virtue of the services they perform, all directed toward the common goal of a marketable product.
 3. Visit a farm with several major enterprises. Make a survey of all buildings and conveniences and determine their use. Many will perform services for more than one enterprise. Have students list under each enterprise the buildings and conveniences which render a service to that enterprise and tell the specific service rendered. Show how the services work together toward a common goal in each enterprise.
- F. The nature and degree of building services required depend upon type of farming, temperature, rainfall, elevation, topography, and soil type, and will vary accordingly.
1. Temperature ranges and rainfall vary considerably from area to area. The degree of protection necessary to keep animal stresses down and protect stored crop products

and machinery from deterioration will vary accordingly.

Elevation and topography are particularly important considerations in providing drainage and keeping livestock and stored crop products and machinery dry. A large number and variety of building services may be required for certain crop or livestock enterprises in a very hot or very cold and wet climate, other enterprises may be more suitable to the climate and require fewer services.

Soil type is directly involved with drainage or erosion problems and certain soil types will not support heavy buildings.

Suggestions for teaching

1. Make a comparison between statistics on local weather, soil, and topographical conditions and statistics from one or two other areas. Compare temperature, seasonal distribution and amount of rainfall, number of days that rain fell, relative humidity, depth of snow pack, number of days snow was on ground, soil type, topography, elevation, and so on, in relation to the type of farm enterprises and building services required. A given amount of rainfall on one soil type or one set of topographical conditions

would cause flooding or drainage problems; under other circumstances it would not. Temperature and humidity have a great effect on animal comfort. Certain soil types will not support heavy buildings. An appreciation for the influence of local conditions upon the farm building aspect can thus be cultivated.

2. Observe several farmsteads in the community where soil, elevation, and topography vary. A farmstead on bottomland might have better protection from wind and driving rain, but the heavier soil and flat topography might make drainage a problem. At a higher elevation, drainage problems might be replaced by erosion problems, temperatures might be lower, snow might stay longer, and so on. The location of the farmstead on a given farm in relation to sheltering hills, groves of trees, or natural drains can be pointed out. All of the above factors in turn have an influence on the farm enterprises carried on.

Structural Principles

1. The forces controlled by farm buildings and conveniences in carrying out their functions act to weaken, deteriorate, and/or destroy the building or convenience.

Forces and stresses of external origin

Wind

Precipitation (moisture and snow loads)

Temperature

Microorganisms (rot)

Rodents

Insects

Fire

Earthquakes

Floods

Oxidation (rust)

Sunlight

Forces and stresses of internal origin

Weight of building contents

Weight of building components

Vibration of machinery

Short duration loads from livestock in functional areas

Corrosive effects of livestock waste products

Corrosive effects of stored crop products

Corrosive effects of petroleum products

Humidity from transpiration by animals and stored crop products.

A. Stresses and forces to which farm buildings and conveniences are subjected have varying effects upon different building

materials.

1. Material

Wood

Advantages

High strength per unit of weight.

Redwood and cedar are fairly resistant to rot.

Disadvantages

Affected by moisture -- loss of strength,
warping and distortion, rot.

Combustible

Attacked by insects and rodents

Concrete

Advantages

Strong in compression

Resists wear well

Does not rot or decay

Not attacked by insects or rodents

Fire resistant

Moisture resistant

Disadvantages

Weak under tension (brittle)

Heavy

Iron

Advantages

and

Relatively strong under both tension and com-

Steel

pression (ductile)

Not attacked by insects, rodents, or rot

Fire resistant

Disadvantages

Relatively heavy

Rusts readily

Subject to fatigue failures (vibration)

Good conductor of electricity

Aluminum Advantages

Very strong per unit of weight

Reflects heat well

Highly resistant to fire, corrosion and decay

Disadvantages

Softer than steel or iron

Good conductor of electricity

Plastic Advantages

Resistant to moisture, decay, corrosion, insects, and acid

Some types transparent

Flexible

Disadvantages

Heavier than wood per unit strength

Subject to fatigue failures

Clear type not resistant to sunlight

Becomes brittle in low temperatures

Combustible

Suggestions for teaching

1. Ask students to name some of the most common building materials. After a list has been compiled, ask which one is the best. They will very likely say "It depends", depending, of course, on the use to which it is put. Ask why glass is used for windows instead of wood. (It is transparent, of course.) Why isn't glass used for walls and floors? The advantages and disadvantages of various materials can be compiled this way.
 2. Take a number of common building materials and expose them to different stresses as a demonstration. Heat, bending, moisture, electrical, and vibrational stresses can be easily applied with shop facilities. A framework for discussing other stresses will be thus provided.
- B. The nature and intensity of stresses and forces to which a building is subjected governs the type of material used in the construction of the building.
1. Concrete is most suitable for floors, lower portions of walls, or anywhere where moisture and corrosive

materials may be abundant, fire hazard is high, and the weight of the building material is not an important factor.

Wood is generally suitable for walls, roofs, ceilings, and doors, where high strength per unit of weight is necessary, moisture is not prevalent, and fire hazard is low.

Iron and steel provide high strength with little bulkiness, and are suitable where fire hazards, insects, rodents, rot or decay organisms are prevalent, as in the case of stanchions, railings, feed storage facilities, and corrals.

Aluminum may often be used in place of iron or steel where considerations of weight or corrosion are important.

Plastics are often used to admit light to a building. Plastic sheeting is flexible and can be easily adapted to various protective purposes, usually of a temporary nature.

Suggestions for teaching

1. Ask students what material they would use to build a perfect building; one which would resist all the forces and stresses previously studied. The answer might be solid rock. You could point out that an earthquake could easily topple such a building. What

could be used in combination with rock to give it more strength? How about an all steel building? Would steel be the best material to use for a foundation? The combination of materials for greatest strength and durability could be thus approached.

2. Use the various ages through which mankind has progressed to illustrate developments which have enabled man to build larger and better buildings. Man lived in caves at one time. The stone age provided him with crude tools to make shelters from wood and vegetation. Later bronze and iron were discovered, and used in combination with previously learned building techniques. Concrete, steel, aluminum, and plastic have arisen from the machine age and are widely used because they do many jobs better than previously available material.
3. Both of the preceding sub-principles could be put across by visiting a farmstead to specifically observe the different types of materials used in buildings, and where and why they are used. The why will be obvious in many cases, not so obvious in others. Students will have to give considerable thought to why one material is used over another in some cases.

C. The assembling of building materials in certain ways increases the ability of the building material and the building as a whole to resist stresses and forces.

1. The shape of a triangle cannot be changed without changing the length of one of its sides. This principle is made use of in building construction in the form of braces and trusses which help resist physical forces. Arrangements which result in short lever arms reduce the ability of forces to cause damage to building components.

Building materials are combined when one material alone will not resist the various forces to which a building or a particular part of a building is subjected. Steel is used to reinforce concrete where high durability plus resistance to tension is needed. Wooden studding is used to protect aluminum building skins from damage by livestock or machinery from the inside of the building.

Suggestions for teaching

1. A number of simple demonstrations will illustrate this principle. Showing how a triangle cannot be changed in shape without changing the length of one of its sides is a good way to illustrate the importance of braces and trusses. Demonstrating the three

classes of levers and showing some shop tools as examples of utilizing the different classes would serve as a basis for other structural considerations, such as high walls, long overhangs, or cantilevered roofs.

2. A visit to a group of houses in various stages of construction would serve as an excellent means to point out the combined use of many materials. Steel used to reinforce concrete, braces and trusses used to support the roof, bolts used to hold the mud sills to the foundation, and many other examples would be evident.

D. Resistance to chemical and biological forces can be increased by applying protective materials to materials commonly used for construction.

1. Paint protects wood against excessive moisture or excessive dryness. It also protects iron and steel from oxidation.

Creosote or similar chemicals make wood resistant to rot organisms and insects and rodents.

Galvanization (a coating of zinc) is applied to iron and steel which will be subjected to conditions conducive to oxidation.

Wood can be treated chemically to make it fire-resistant.

Suggestions for teaching

1. This is not a complex principle and most students probably already grasp it fairly well. Subjecting treated and untreated material to chemical and biological forces as an experiment would be one way to reinforce this principle.
2. Point out some examples where certain materials are used in situations where previously learned information deemed them to be unsuitable. Pole type buildings utilize wooden poles buried in the ground where moisture is high. Steel pipe is also buried underground. Wood is exposed to sunlight and moisture on the outside of a building. Special treatment enables this material to resist these forces and stresses to a higher degree.

Economic Principles

1. Farm buildings and conveniences are part of a farmer's capital investment which, along with land, labor, and machinery, are used in the business of agricultural production.
 - A. The margin of profit realized by a farmer, which is a function of the quantity and quality of agricultural commodities

produced and marketed, is directly and indirectly affected by the performance of building services.

1. Direct effects

Buildings reduce or eliminate many stresses which affect an animal's ability to produce meat, milk, eggs, wool, and other products. Health stresses, such as diseases and parasites, environmental stresses, such as heat or cold, and sociological stresses, such as "bossy cows" and cannibalism, require the animal to use energy. If these stresses are reduced or eliminated, more energy remains for production.

Buildings reduce or eliminate deterioration and loss of stored crop products which may be affected by rodents, insects, microorganisms, moisture, heat and cold. They also provide for storage until marketing conditions become more favorable.

Indirect effects

The efficiency with which machinery and labor function in the general farm operation will be affected by the degree of protection from environmental stresses afforded by buildings, thus bearing indirectly upon production of agricultural commodities.

In providing an attractive appearance, buildings help create an atmosphere which is helpful to the farmer in business pursuits.

Suggestions for teaching

1. Briefly review building services with the students, then ask them some specific ways in which these services affect the margin of profit realized by the farmer. While both the quality and quantity of products marketed are affected by building services, the particular importance of the quality should be emphasized. The difference between Grade A and Grade B milk, Number one and Number two hay, choice and good steers, is influenced to a greater or lesser degree by building services. Efficient use of machinery and labor are good examples of indirect effects. Having machinery in operating condition at the proper time to plant or harvest will favor profitable marketing. Any number of specific effects of building services can be shown.
2. Outline the transition of man from a nomadic state to a stationary state and trace the advancements made in the ability of man to produce more than enough agricultural commodities to meet his family's needs.

The cultivation of crops was the first step in becoming stationary. The role of building services in the gradual increase in quality and quantity of crop and livestock products is easy to point out.

B. The expected increase in net income resulting from services to be performed by a building or building system governs the amount to invest in that building or building system.

1. The difference between the cost of constructing and maintaining a building or building system and the resulting increase in gross income during the useful life of the building should be the maximum possible.

Illustration

Building A	Cost for 10 year period . . .	\$10,000
	Increase in gross income	
	\$2,000 per year	\$20,000
	Total increase in net income	\$10,000
Building B	Cost for 10 year period . . .	\$15,000
	Increase in gross income	
	\$2,200 per year	\$22,000
	Total increase in net income	\$ 7,000
Building C	Cost for 5 year period . . .	\$ 6,000
	Increase in gross income	
	\$2,000 per year	\$10,000

Total increase in net income \$ 4,000

Building A is the best choice since it increases net income by \$1,000 per year.

Suggestions for teaching

1. Set up a specific example based upon the prices of Grade A and Grade B milk, showing how much a farmer's gross income could be increased if he could produce Grade A milk. Then determine how much he could afford to invest in a building to enable him to produce it. Show that if the cost of a building over a period of years was too high it would offset the advantage of the higher selling price of the milk. However such a building might reduce labor requirements or have other effects which would offset part of the cost of the building.
2. An analogy between applying fertilizer to a depleted soil and furnishing building services for a farm enterprise would show the principle quite clearly. A small amount of fertilizer would pay for itself many times over. As the amount of fertilizer is increased, however, the additional benefits are less dramatic, until a point is reached where little or no additional benefits are realized by subsequent increases in

fertilizer and the cost of additional fertilizer exceeds the benefit derived. Building services are much the same. Simple protection from environmental forces yields great returns, but as services become more refined and complete there is a point beyond which additional services do not result in enough benefits to justify the cost of providing them.

C. Building obsolescence results from changes in farming practices which eliminate the need for the services performed by a building before physical deterioration has substantially impaired its ability to perform these services.

1. A building or building system is obsolete when there is another building or building system which will give better benefits, after the cost of conversion or replacement has been taken into consideration. To avoid obsolescence, a building must meet one of the following conditions:

Be designed to fit most conditions expected in the future.

Be designed so it can be changed to meet future conditions.

Be designed for a short life at a low cost.

Low cost buildings of short life are found to be most economical at present. The cost per year is high but the total usefulness during the life span is also high.

Suggestions for teaching

1. Most students have been through museums or have seen or studied about weapons of war which have been used over the years. Many good examples of obsolescence are available here. A steel sword, for example, may be just as able to perform the service for which it was designed now as it was a hundred years ago. Cavalry troops could chase down Indians just as well now as they could eighty years ago, if there were any Indians to chase. In some cases these weapons have found new uses to meet changing conditions. Searchlights used to spot slow-moving propeller planes in World War II are useless today against jet aircraft but were used in Korea to light up the countryside for night fighting. Some military aircraft have been converted for civilian use. Comparable changes in farming practices can be pointed out to show how buildings become obsolete and how future changes should be taken into consideration when planning and investing in a building.
2. Outline the transition of agriculture from a diversified family farm to the specialized business we see today. Show how practices changed very slowly until

agriculture became mechanized. The effects of modern technology on farming practices is one of constant change and improvement. The necessity of buildings being planned with these changes in mind can easily be brought out.

3. Ask a student who has a number of smaller brothers and sisters if he can remember what the first house he lived in was like, or if he has lived in the same house all his life, what changes have been made as his family grew. Chances are that they started out with a small house, then either built on or moved to a larger house. Ask him what he thinks his parents will do when all the children are grown. They would probably prefer to move to a smaller house again. The changing conditions involved in raising a family demand various services at various stages. Changing conditions in agriculture are similar, but not as easily predicted.

D. The amount of capital necessary to establish a given building or building system depends upon the cost of materials, the cost of labor, and overhead costs.

1. The cost of materials varies with availability, quality and quantity purchased, transportation to the site, and

storage at the site.

The cost of labor varies with labor management, skills required, season of year, and workability of materials.

Overhead costs are costs of planning, managing, purchasing, and insuring.

Suggestions for teaching

1. Ask the students to recall the various types of building materials studied, and how their properties vary. A building made almost entirely of steel or reinforced concrete would have some great advantages, once built. Why would a farmer be unlikely to do this? In some parts of the West, fences are built from stone. Why? Why would it be cheaper per building to build ten buildings of the same type rather than two? A line of questioning like this will bring out the various factors such as labor, availability of materials, discounts, and overhead costs, which are involved in the total cost of erecting a building.
2. Ask students if any of them have had some repairs done to their car lately. Take the amount of the bill and break it down into cost of materials and cost of labor. Would the cost of the parts be less if a dozen

had been purchased? Could it have been higher if it had to be procured from a distant city? Was the total amount you paid for labor given to the mechanic in the form of wages? Where did the rest go? A scheme will soon unfold which will be analagous to the costs involved in erecting a building.

3. A building contractor or someone who has had a lot of experience in the management phase of construction could give the class considerable insight into the costs involved in building. It would be necessary for the instructor to show him beforehand what he wanted the students to learn, and warn him to keep his explanations simple and understandable. One approach might be to have him explain some of the alternatives with which he is faced in his business and how factors of labor, materials, and overhead costs affect his decisions.

E. Expenses additional to those incurred in the initial construction of a building or building system are incurred in the operation and utilization of the building or building system.

1. Mechanical maintenance is required to sustain the building's ability to resist those forces which would impair its ability to perform building services. Insurance costs

are incurred to protect the investment in the buildings.

Interest on investment.

Use value of the land the building is on.

Suggestions for teaching

1. The automobile can again serve as an analogy for this principle. Most students know, or will soon find out, that expenses do not end when a car is purchased. The cost of maintaining, insuring, and registering an automobile can easily be compared to similar costs incurred in the utilization of farm buildings.
2. Ask the students what are some of the tasks they see the school janitor doing. What would be done if the school plant burned down or was otherwise destroyed? If the school were not a government agency, what expenses would it be subjected to? Many of the expenses above initial construction costs can be pointed out this way.
3. Select some farm account books from past years and have students go through and try to find all costs related to buildings and conveniences. Point out the items they might have missed, such as interest on

investment, and explain the importance of taking these costs into consideration.

Unit Exercises

Several activities are suggested below to serve as a unifying exercise to test the student's ability to apply the knowledge he has gained. As in the case of previously suggested activities, they are stated in general terms, and considerable latitude is allowed. It is hoped that the students themselves can have a voice in choosing the exercise they will perform, and that they can actively participate in defining the exercise more specifically than has been done here.

1. The first exercise suggested is a creative planning project. Students should select or be assigned a problem which requires planning a building system for a specific crop or livestock enterprise. The specific conditions, such as quantity of livestock, acres of land, product to be marketed, location of farm, and so on, should be established. Criteria for evaluation of the building system should be established from previous studies. Then a number of plans should be drawn for building systems to meet these specific conditions. This does not mean drawing blueprints for each building, but merely indicating size, shape, and type of construction, and what services it provides. The arrangement of the buildings in relation to each other is also important. Flexibility of the

system, adaptability to changing conditions, and many other factors should be considered. Unusual or unconventional ideas should be encouraged, not discouraged, and the emphasis should be upon creating a large number of plans at this stage. The next step is to evaluate each system according to the criteria previously established and select the most feasible system.

2. A farmstead judging contest is another activity which would serve to tie things together. Ask students to tell some of the things they will look for on a farmstead, now that they have studied farm buildings. Briefly review what has been studied and compile a list of things to look for and be conscious of when observing farm buildings and building systems. Classify these into a number of categories and, if desired, assign a weight to each. The result will be a scheme similar to a dairy cow score card. Then conduct a judging contest by visiting several farmsteads and having the students judge each according to the prepared scheme, and later prepare reasons for their placing.
3. Make a field trip to observe a particular building system in preparation for an exercise on how it could be modified to serve a different enterprise. Have students draw a rough map of a dairy building system, for example, and gather pertinent information on type of construction, functional areas, distance between buildings, acres of land on farm, and so on. Then tell them their problem

is to put this system to use for hogs. Some buildings may have to be eliminated, others combined, still others modified or moved, and some new buildings added. Again, unusual or unconventional ideas should be encouraged and the first objective should be to come up with a large number of plans. Then judge them according to feasibility and select the best one.

IV. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Vocational agriculture instruction in mechanical technology has emphasized "knowing what" more than "knowing why" and has been based largely upon teaching those specific manipulative skills which are essential for success in farming or closely related occupations at the time the instruction is offered. The development of the agricultural industry has brought breadth to the farm-to-consumer process and depth, diversity, and specialization to the echelons of employment. The significance of mechanization is readily observed in nearly all phases of the industry and the increased productivity and efficiency resulting from mechanization have stimulated the industry to continually make further and broader mechanical advancements and refinements. Therefore persons seeking employment in the agricultural industry must not only be able to cope with present mechanical considerations but also must be prepared to modify, adapt, increase, and improve their mechanical competence with changing conditions. Such a situation clearly shows the limitations of instruction consisting primarily of teaching skills, and suggests a need for an approach which imparts generalized knowledge and provides broad frames of reference, thereby preparing students to cope more effectively with changing mechanical applications in agriculture.

Related literature indicates that the purpose of formal education is to prepare students to participate intelligently in society and contribute to the improvement of future societies. Knowledge gained by past generations is heavily relied upon for such preparation. Societal change in recent years, however, has been so rapid that maintaining an enlightened place in society becomes increasingly difficult with increasing age. The trend in our society toward increased dependence upon mechanization in conjunction with the rapid birth of new technical innovations and more sophisticated production techniques has resulted in a serious "skill obsolescence" problem for those employed in technical occupations. Workers have not been educated or trained in a manner which allows them to maintain a high degree of flexibility in the skills by which they earn a living.

The agricultural industry shares this "skill obsolescence" problem. Literature clearly shows the evidence of the rapid increase, constant change, and broadening significance of mechanization in agriculture. Objectives for mechanical technology instruction listed by the Department of Health, Education, and Welfare make it evident that teaching of skills alone will not result in the accomplishment of these objectives. A number of authors have advocated the teaching of principles to students of vocational agriculture to better equip them to cope with change. Skills must be supplemented by something less transient in nature. Little evidence exists to show that comprehensive

efforts have been made to identify, classify, and establish methods of teaching principles applicable to mechanical technology in agriculture.

The investigator's special interest in mechanical technology in agriculture prompted him to undertake a study to identify principles which could be used to teach a limited portion of the mechanical technology curriculum of the vocational agriculture program of instruction. A course taken at Oregon State University familiarized the investigator with knowledge pertaining to Farm Buildings and Conveniences. The acquaintance established with the instructor and his broad, generalized approach to teaching this subject made it convenient to concentrate on Farm Buildings and Conveniences, one of the five generally accepted areas of mechanical technology instruction in high school vocational agriculture programs.

The investigator formulated a number of principles, sub-principles, bodies of supporting information, and suggested teaching procedures pertaining to Farm Buildings and Conveniences based on his personal knowledge and a review of pertinent literature. Five subject matter specialists and teacher trainers from the faculty of Oregon State University participated in an initial review and revision of this material, after which it was submitted to a number of vocational agriculture teachers previously contacted who tried portions of the material in actual teaching situations. Interviews were held

with these teachers to determine the suitability of the material as a resource unit for teaching, and opinions, suggestions, and criticisms on the entire body of information gathered during these interviews served as a basis for a second revision.

Summary of Findings

Interviews held with vocational agriculture teachers showed substantial agreement on the following points:

1. The findings are useful in teaching broad principles and concepts.
2. The content and organization of the material lends itself favorably to the inductive teaching procedure, students enjoyed its use, arrived at the principles inductively in many cases, and could state them in their own words.
3. The availability of the findings reduced the amount of research and consolidation necessary on the part of the teachers and increased teaching efficiency.
4. Suggested teaching procedures are particularly helpful to beginning teachers and are useful to all teachers in providing new ideas or fresh approaches.
5. The principles and sub-principles included are closely related to broad considerations of farm management, and unifying exercises, while desirable, would be more conveniently

undertaken during farm management classes, rather than being taken up separately.

6. The supporting information is particularly useful in providing information with which to teach.
7. The principles and sub-principles have a high transfer value to other areas usually taught in vocational agriculture classes and to general problems of adjusting to society as well.
8. Studies in the other four areas of mechanical technology instruction would be similarly helpful to them.
9. Vocational agriculture teachers in the field do not have the time or the resources to undertake such studies or to research and consolidate such material for their own use.

Conclusions

The areas of substantial agreement cited provide a limited basis for a number of conclusions:

1. That principles applicable to mechanical technology can be identified, classified and supplemented in such a way as to be useful in teaching.
2. That subject matter specialists and vocational agriculture teachers can contribute to such identification, classification, and supplementation with little fundamental disagreement.
3. That there is a need for such bodies of information in all

areas of mechanical technology instruction to assist vocational agriculture teachers in teaching principles and to increase their teaching efficiency.

4. That while vocational agriculture teachers can contribute to such bodies of information, few if any have the time or resources to undertake their preparation singlehandedly.

Recommendations

1. That the findings be used in a broader study involving a large number of vocational agriculture departments and results be statistically treated to enable more valid and reliable conclusions to be drawn.
2. That the findings be made available to teachers regardless of whether further studies are undertaken.
3. That similar studies in the other four areas of mechanical technology be undertaken.
4. That efforts be made to provide more time and resources for consultants, subject matter experts, and vocational agriculture teachers to collaborate on such studies.

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APPENDIX

Corvallis, Oregon
October 30, 1964

Dear [Vocational Agriculture Teacher]:

This letter is to confirm our conversation of October 27, wherein I asked for your assistance in my endeavor to complete a Master's Degree thesis. As I explained during our visit, I will, with the help of OSU faculty members, develop a tentative unit of instruction in Farm Buildings and Conveniences. This unit will be based upon principles which apply to this field and will be so organized as to encourage the use of the inductive teaching procedure.

I am endeavoring to arrange for a number of vocational agriculture instructors to try part or parts of the tentative unit in their vocational agriculture classes as well as to criticize and make suggestions for the entire unit, to serve as a basis for revision and finalization, and it is in this respect that I have requested your cooperation. I hope to have something prepared to send out by December 1st. In the meantime I will keep you informed as to what progress is being made.

No reply to this letter will be necessary unless I have failed to explain the matter adequately or you feel that you will not be able to participate.

Sincerely yours,

Bill Krueger
403 Weatherford Hall
Corvallis, Oregon 97332

Corvallis, Oregon
November 19, 1964

Dear [Vocational Agriculture Teacher]:

With reference to my recent letter asking your cooperation in my endeavor to complete a Master's Degree thesis, I am pleased to report that substantial progress has been made in the preparation of a tentative unit of instruction in Farm Buildings and Conveniences, and it appears that I will be able to get this material into your hands for review by December 1st or thereabouts.

This material will be delivered to you either by mail or by a personal visit. To facilitate a personal visit, please drop the enclosed post card in the mail, which will indicate to me the most convenient time of day for us to get together.

Sincerely yours,

Bill Krueger
403 Weatherford Hall
Corvallis, Oregon

Corvallis, Oregon
December 1, 1964

Dear [Vocational Agriculture Teacher]:

The tentative unit of instruction in Farm Buildings and Conveniences, about which we have been corresponding, is on its way to you under separate cover and should be in your hands soon. I plan to visit with you briefly on this matter before the Christmas recess, not to conduct a comprehensive review of the material, but merely to get an idea of what portions of it you would like to try with your classes and approximately when you plan to do this. This will enable us to set up an approximate date for a comprehensive review of this material later, after you have had time to digest it more thoroughly.

Sincerely yours,

Bill Krueger
403 Weatherford Hall
Corvallis, Oregon 97332

Corvallis, Oregon
February 24, 1965

Dear [Vocational Agriculture Teacher]:

As you recall from recent telephone conversations or personal contacts, I would like to conduct a personal interview with you sometime before March 15th. The purpose of the interview is to review the unit of instruction on Farm Buildings and Conveniences and, in the case of those who were able to try this material with their classes, to get your specific reactions to its usefulness in a teaching situation. An interview check list is enclosed to familiarize you with the characteristics of the pending interview.

Since this interview could take longer than a free class period would allow, I suggest that arrangements be made to meet after school or during an evening. Saturdays would be fine with me if convenient for you. Please suggest several dates on the enclosed postcard and upon receipt I will notify you when I will come.

Sincerely,

Bill Krueger
403 Weatherford Hall
Corvallis, Oregon 97332

Encl: 2

INTERVIEW CHECK LIST

A set of principles, sub-principles, and supporting information on Farm Buildings and Conveniences was sent to you some time ago. This material was intended to serve as a frame of reference or a body of basic material for teaching this unit in vocational agriculture classes. As vocational agriculture teachers, your help was requested in reviewing this material and making suggestions as to how it may be further refined to better serve its purpose. In addition, arrangements were made with most of you to actually try parts of the material with certain of your classes to more specifically determine its usefulness in a teaching situation.

The following set of questions is designed to systematically gather your reactions to this unit. It is submitted to you for review prior to a personal interview and it is not expected that you answer the questions in writing. You may do so if you wish, but the primary purpose is to familiarize you with the type of questions which will be covered in the interview.

I. General -- Organization of Material

1. Is the division of this material into functional, structural, and economic units satisfactory?
2. If not, how would you alter it?
3. Is the system of listing a main principle for each unit, a number of sub-principles, and a body of supporting information for each sub-principle adequate?
4. If not, how would you alter it?
5. The second portion of this unit consists of some general recommendations on how each sub-principle might be taught? Is this necessary or should it be left up to the teacher?
6. If necessary, should an attempt be made to make them more interrelated and continuous, so that several suggested patterns for teaching each of the three units are presented?
7. Several unifying exercises are suggested which would provide for broad application of the knowledge gained by the student. Is such an exercise desirable?

8. Any other remarks on organization.

II. Content -- Technical Aspects.

1. This will involve a discussion of the principles, sub-principles, and supporting information with reference to technical accuracy and adequacy. Additions, deletions, clarifications, simplifications, rewording, and so on are under consideration. Rather than designate a space in the check list for each item, a notation will be made only of those discussed, such notation being made under one of the three broad divisions. To designate the item under discussion the number and letter scheme in the original material will be used.
2. Similar discussion of suggested methods for teaching principles.
3. Similar discussion of unifying exercises.
4. Any other remarks or suggestions on content.

III. For those who tried portions of the unit with their classes.

1. Which portion or portions of the unit were used with your classes?
2. Within the portion or portions used, which principles were taught?
3. Was the inductive teaching approach used?
4. Did students arrive at the principle and could they state it in their own words?
5. How did students react to the use of this material?
6. Was your teaching more efficient by virtue of having this material to refer to?
7. Would similar bodies of basic information for other areas of the farm mechanics curriculum be of value to you?
8. Any other remarks on use in classroom.