

WHAT PURPOSE AGRICULTURAL ENGINEERING

by

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The word engineering has gone through an evolution or change in definition and meaning which makes it difficult to establish a purpose for engineering which would be satisfactory under all usage. While engineering was originally defined as the art of constructing and managing engines and machines, today it is more generally considered as the application of Science. Therefore as a first step in establishing a purpose for Agricultural Engineering it is necessary to define engineering in three forms as used in the present day.

1. Engineering is the *Profession* in which a knowledge of the mathematical and physical sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically, materials and forces of nature for the progressive well being of mankind.

2. Engineering is a type of *Institution* or *Department* in which a knowledge of the application of the mathematical and physical science gained by study and experience is taught or practised with judgment and intent to develop ways to utilize, economically, materials and forces of nature for the progressive well being of mankind.

3. Engineering is the application of *techniques* or *practices* developed from a knowledge of the mathematical and physical sciences to develop or utilize materials and forces of nature.

Some elaboration of the wording will perhaps help to give understanding to the meaning.

(1) Engineering is defined as a *profession* implying that it ranks with other so-called learned groups in present society such as medicine and law.

(2) The idea of *knowledge* is included and emphasized because it is felt that it is knowledge that distinguishes a profession and that it is knowledge which the professional applies in the accomplishment of his objective. The scope of the knowledge considered peculiar to engineering has been limited to the realm of the mathematical and physical sciences to distinguish it from medical or social sciences. The physical sciences include such items as chemistry, physics, electricity, mechanics of solids, thermodynamics, fluid mechanics, etc.

(3) *Study, experience, and practice* are enumerated because these are the

items by which an engineer is judged and which he must, in fact, prove if he is to be accepted as a professional by any legal jurisdiction.

(4) The idea of *judgement* is included as well as the subject of economics as both are considered important phases of engineering activity. Whether or not a matter is economical or practical is usually a matter of judgement. In addition, many engineering decisions are made in areas not subject to specific and accurate analysis.

(5) The words "to utilize economically the materials and forces of nature for the progressive well being of mankind" are intended to convey, first that economics is a primary consideration in all engineering, and second, that the engineer's tools are the resources of nature and his aim is to improve human welfare.

(6) It is implied that an engineering *institute* or an engineering *department* is made up of people applying their knowledge of mathematical and physical sciences either by interpretation to others or in actual practice.

(7) It should also be pointed out that engineering as an *operation* is merely a means to an end and that it is the person carrying out the operation that gives the ultimate purpose to engineering.

Although emphasis is placed on the person doing engineering it is not intended, at this time, to elaborate on requirements or qualifications except to point out that to be an engineer a man must have a predetermined minimum knowledge of the mathematical and physical sciences gained by study, experience, and practice in order to be considered eligible to apply this acquired knowledge with judgment to develop ways to utilize economically materials and forces of nature for the progressive well being of mankind. In other words, he must have a certain amount of knowledge and an understanding of the purpose for the application of the knowledge. These minimum standards and criteria are set by and are the responsibility of Universities and registering Associations of Engineers. The University setting the requirement for the knowledge aspect and the Associations of Engineers for the experience and practice.

By affixing an objective adjective to the word engineering, the scope of the application of the knowledge of the mathematical and physical sciences is defined. In this case agricultural engineering limits "the materials and forces of nature" to include those which are directly or indirectly a part of the total agricultural production and industry field. This includes the production, processing, transportation and utilization of its produce and by-products; the efficient utilization and conservation of its natural resources and the requirements of related industries and services.

The problem in agricultural production are usually complex and in total require many basically inherent phases of a number of disciplines of engineering. It has become accepted therefore, that agricultural engineering in its broad field of operation is comprised of four rather clearly defined areas.

1. Farm Power and Machinery

The purpose of engineering in the farm power and machinery field might well be described as the application of knowledge of mathematical and physical sciences, to develop ways to utilize economically the energy sources of nature for agricultural production. This includes what is commonly accepted as investigation into methods of utilizing present sources of energy as well as developing new sources of energy, the design of equipment which utilizes energy and the insuring of efficient operation of power units and equipment.

2. Farm Structures

In the farm structures area, engineering is the investigation and development of ways to utilize materials and forces of nature for functional and efficient buildings. This is meant to include design, techniques of fabrication, labour saving arrangements, and new material uses to permit economical cost, efficient utilization of labour, satisfactory sanitation, comfort, and condition for the housing of livestock or the storing of agricultural products or by-products.

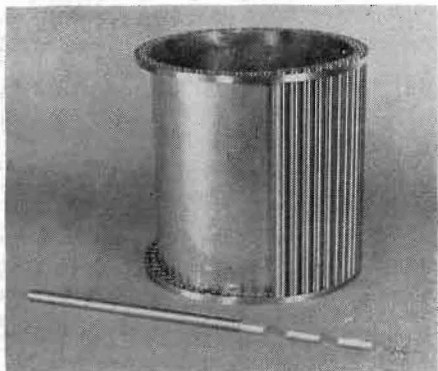
2. Electric Power and Processing

The electric power and processing area requires engineering to investigate or to develop ways to utilize materials and forces of nature for the production, control, and processing

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used on a 24 hr. basis for irradiating such items as plastics, chemicals, wood products, foods and drugs for our own Division and other departments including the Central Experimental Farm, Food and Drug Directorate, Forest Products Laboratory and the National Research Council.

The irradiation cavity is a cylindrical volume 6" in diameter and 8" in height. Presently the facility contains about 4000 curies of Cobalt 60 with a central field of about 350,000 r/hr.



Source container for Cobalt 60 gamma irradiator "Gammacell 220". The stainless steel cylinder 8" in diameter x 8" in height holds 54 stainless steel sealed rods. Each rod contains 7 radioactive cobalt plugs 1/4" diameter x 1" height sealed in 1/16" aluminum jackets. During irradiation, samples are surrounded by the cylindrical array of cobalt 60 pencils, ensuring a gamma field with good uniformity. (Photograph -- Courtesy, Commercial Products Division, Atomic Energy of Canada Ltd.)

Enough shielding has been built into the unit to triple the present activity and hence, increase threefold the resultant field to approximately 1 million r/hr. Samples can be removed automatically after pre-set exposure times up to 120 hrs. using the automatic timer. Provision has been made also for using coolants or heaters around the samples being irradiated.

Since the facility is adequately shielded it can be installed in any laboratory without the requirement for a special shielded room. We have found the facility very convenient to use for our co-operative experiments, since samples can be irradiated minu-



The effect of increasing doses of gamma radiation on the sprouting of Katahdin potatoes. The tubers are shown after 5 1/2 months storage at 55°F following irradiation. Irradiation doses were as follows: Top left—controls (no irradiation), Top Centre — 1700 rep, Top right—3400 rep, Bottom Left—5100 rep, Bottom Centre—6800 rep, Bottom Right—8500 rep. (Photograph — C. Posselwhite, Central Experimental Farm, Ottawa.)

tes after preparation. In addition, irradiations are easily reproducible where it is necessary to repeat a given experiment. Another advantage is that irradiations can be performed without packaging samples in waterproof containers as is necessary with the trench facility.

Large Scale Irradiation Facilities

In addition to developing laboratory gamma irradiation facilities, the Commercial Products Division is also considering design proposals for much larger scale facilities. For example, design proposals for a large scale plastic pipe irradiator and a production scale potato irradiator have already been considered by our Division. The proposed potato irradiator would contain some of the following features: capable of handling production quantities; a built-in conveyor system to accommodate bulk or bagged potatoes; convenient to use; designed to deliver a uniform dose and easily moved from one location to another.

As mentioned earlier, both the United States and Russia are in the process of building or already have in operation several large scale gamma irradiators.

The following factors will be important in the design of an irradiator for a particular application: the dose to be received by the material; the range of dose permitted in the material being irradiated i.e., the spread from minimum to maximum dose; the type and size of container or package; the weight limitations if a mobile unit is considered; and the rate of throughput required for a large scale operation.

When considering the economics of a large scale facility, one important factor is the number of hours usage per year. Since gamma sources emit radiation continuously, it is desirable to operate for a maximum number of hours per year in order to keep the processing costs per lb. down to a minimum. If a particular application is seasonal in nature, it would be desirable to find an alternate use for the unit during the off-season.

A second important economic factor in the design of an irradiation facility will be the efficiency of utilization of radiant energy available. The ideal arrangement would be one where 100% of the total available energy is absorbed by the material under irradiation, however, this would be difficult to achieve in practice without exceeding other limitations such as the size of the unit and the weight of the shielding.

The final design will be a compromise of all the above factors, the relative significance attached to each depending on the particular application.

As more applications of radiation are developed in the laboratory or on a pilot plant scale, more specific and detailed designs will be forthcoming for commercial facilities.

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of agricultural products and by-products. This includes efficient use of electric energy for power utilization and control operations, the processing of produce and the conditioning of structures to insure quality control of products.

4. Soil and Water Conservation Engineering

This area perhaps more appropriately defined, as management, control, and utilization of water resources, requires engineering in investigating or developing ways to control, manage, and utilize water for the efficient production of crops and the conservation of natural resources.

Since knowledge is the basic ingredient in the engineering operation, limited only in scope by the nature of its application, it must be evident that as new knowledge in the mathematical and physical sciences is made available, that study and experience must be a continuing process in order that this new knowledge may be applied with the best judgment possible to the many complex problems in agriculture, if agricultural engineering is to serve its main purpose in this regard. It must be realized that while the purpose of agricultural engineering in theory does not change, the means by which it is achieved is continually in a state of change or development. Therefore, the challenge in agricultural engineering is:

(1) To gain new knowledge in the sciences.

(2) To study and investigate its potential value in the agricultural field.

(3) Through experience, to apply it with the best judgment possible to either the development of new ways or to methods of improving already established techniques to utilize economically the materials and forces of nature for the problems in agricultural production, processing, transportation, distribution and services.