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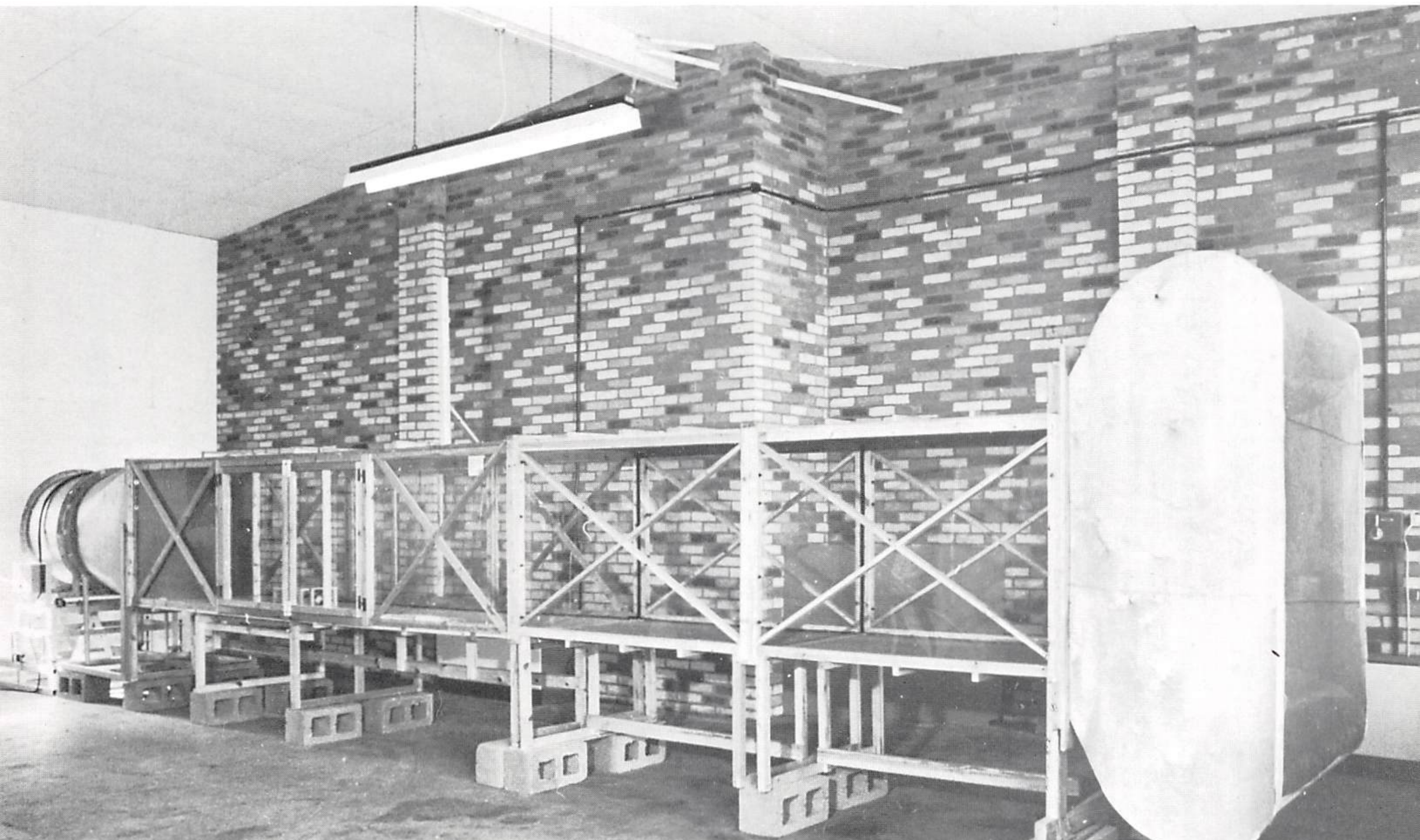

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Cover picture: Wind tunnel used for farm building ventilation studies (see paper by A H A Abdel-Reheem and M P Douglass).

Effect of adjacent structures on farm building ventilation

A H A Abdel - Reheem BSc PhD
M P Douglass MSc MIAgrE

Introduction

AIR flows through a building as a result of the difference in pressure set up across its openings. The external pressure on an opening is that of wind while the internal pressure results from one or more of three agencies, namely (a) wind effect, (b) thermal effect and (c) fan effect.

The effect of wind on a building manifests itself as pressure increase or decrease (suction) on the building sides and roof relative to the free stream static pressure. The pressure or suction on building surfaces is different from point to point and is a function of factors such as building shape and size, wind speed and direction as well as the shielding effect from other buildings (or objects) sited around it.

The way in which adjacent structures affect wind pressure distribution on building surfaces and air flow patterns around them has been the subject of study by several investigators eg Bailey, *et al* [2], Ning Chien *et al* [8] and more recently Kelnhofer [4] and Ishizaki, *et al* [3]. On the subject of natural ventilation by wind, Weston [10] studied the rate of air movement in an industrial building as affected by an adjacent building. Krishnan [6] reported an empirical formula giving the minimum distance of separation between identical blocks of buildings for adequate ventilation as

$$D_m = 0.4\,h\,\sqrt{B}$$

where D_m = the minimum distance of separation

h = the height of the building

B = the length of the building.

He considered that ten times the height of the building is the optimum separation.

Almost all ventilation systems in livestock buildings are affected by nearby structures. Since an adjacent structure is a factor determining the wind pressure distribution on a building's surfaces, this influences the rate of air passing through the building openings. Accordingly it also influences the air velocity distribution within the building and, in turn, the comfort and productivity of housed stock.

In the case of fan ventilation systems, wind pressure on a building can produce a pressure head across its openings representing several times that produced by a fan, particulary during periods of high wind. This pressure may oppose or work with a fan depending upon the system of ventilation (extraction or pressurisation) and upon the position of the openings in the building. Also, wind pressures are known seriously to interfere with fan working [4] and may impair fan efficiency.

Adjacent buildings can therefore be utilised as a factor for alleviating the effect of wind on a fan ventilation system if sited properly relative to the building to be ventilated. Alternatively they may affect the system detrimentally if the position creates extra wind pressure on the fan.

Consequently, studies are required on the effect of neighbouring building in order that the design conditions for a ventilation system can be obtained. Since there is a large number of variables involved in such a study (eg building shape, size, separation space between buildings, wind speed and directions, opening configuration and position in the building), wind-tunnel tests provide the only readily usable method of determining the best relative positions of buildings in each individual case.

List of Symbols

C_p Wind pressure coefficient: suffices W and L refer to the coefficient at the centre of the windward and leeward openings respectively.

C_{p_t} Internal pressure coefficient of fan ventilated buildings under wind effect.

h Height of buildings.

L Distance of separation between buildings.

Δp Wind pressure on the building: suffices W and L refer to the wind pressure at the centre of the windward and leeward openings respectively.

Δp_f Internal building pressure of fan ventilated building in still air.

Δp_t Internal building pressure of fan ventilated building under wind effect.

R_t Resistance set up on the fan due to wind effect.

Q_f Extracted rate of air flow by the fan corresponding to Δp_f.

V_h Wind velocity at height h.

Experimental Measurements

In studies made to investigate the influence of wind on forced ventilation buildings, the effect of an adjacent building was one of the factors considered. Models of buildings were tested at the National College of Agricultural Engineering [1] in a seven metre long "boundary layer" wind-tunnel, having a one metre square cross-section. In the tests, measurements were carried out on one model, and one or more identical models were used to represent the adjacent building either upwind or downwind of the tested model. These arrangements resemble those usually found in modern intensive poultry systems.

The tested model was equipped with removable panels in the windward and leeward walls and a range of openings of different sizes could be fitted in the panel spaces. A further pair of panels was equipped with pressure tappings and could be used in place of the openings.

Models were constructed from perspex sheet being 297 mm long, 196 mm wide and 157 mm to the ridge; eaves height was 107 mm. The validity of using the models in the study had been confirmed in previous work by comparison of results obtained from a full scale building and its model [1].

Experimental technique

In the experimental measurements made, the wind-tunnel was run at a constant air speed of 8.4 m/sec while measurements were taken on the tested model for various distances of separation between models. The distance of separation L between buildings was considered relative to the model height h as a dimensionless ratio $\frac{L}{h}$. Wind pressure on the building and the static pressure within the building were expressed using the free stream static pressure as a datum. Since these pressures are a function of the free stream velocity head, the latter was used as a normalising factor to obtain the dimensionless wind pressure coefficient C_p and the internal pressure coefficient C_{p_t}. Measurements in these tests were made only for the wind direction normal to the long axis of the building.

The tested model was connected by a tube to a vacuum pump under the tunnel floor, used for extracting air from the model. With the tunnel fan stationary, a known flow Q_f was extracted while the corresponding pressure Δp_f measured. The air flow Q_f was held constant during the measurements when the tunnel was in operation. The internal pressure Δp_t was then taken for each distance of separation.

The wind pressures Δp_W and Δp_L at the openings were also measured for each arrangement of buildings.

Results

The wind pressure coefficients at the windward and leeward openings were plotted against the distance ratio $\frac{L}{h}$ as shown in fig 1, 2 and 3. When the adjacent building was sited on the windward side of the tested model (fig 1) the wind pressure on the windward side of the tested model showed greater variation than the pressure on the leeward side. In the range of $\frac{L}{h}$ = 0.2 to 1.2 approximately, the wind pressure on the windward side was lower than that on the leeward side. This means that the direction of flow through the openings in the building (in the case of ventilation by wind only) would be from the leeward to the windward side ie opposite to the main flow direction. The positive and negative wind pressure coefficient on the windward side and leeward side respectively attained the maximum values as $\frac{L}{h} \to \infty$ ie with the building in isolation, as shown in the same figure.

With the tested model to windward of the adjacent model there was no effect on the pressure on the windward wall of the tested model (fig 2). However, in the same situation the wind pressure on the leeward side was more responsive to the existence of the neighbouring building than in the previous case of fig 1.

When the tested model was placed between two identical buildings sited at equal distances, as shown in fig 3, the results showed similar patterns to those of fig 1. The wind pressure on the leeward side in this situation was generally higher than that shown in fig 1.

The internal pressure of a fan ventilated building would be constant if the situation outside were calm. But in windy conditions the internal pressure changes and, in turn, the resistance on the fan.

With air being extracted through the model at a constant rate corresponding to Δp_f = 2.5 N/m^2 (measured in still air) the tunnel was switched on. The relationship between the internal pressure and the value of $\frac{L}{h}$ was recorded and plotted as shown in fig 4, 5 and

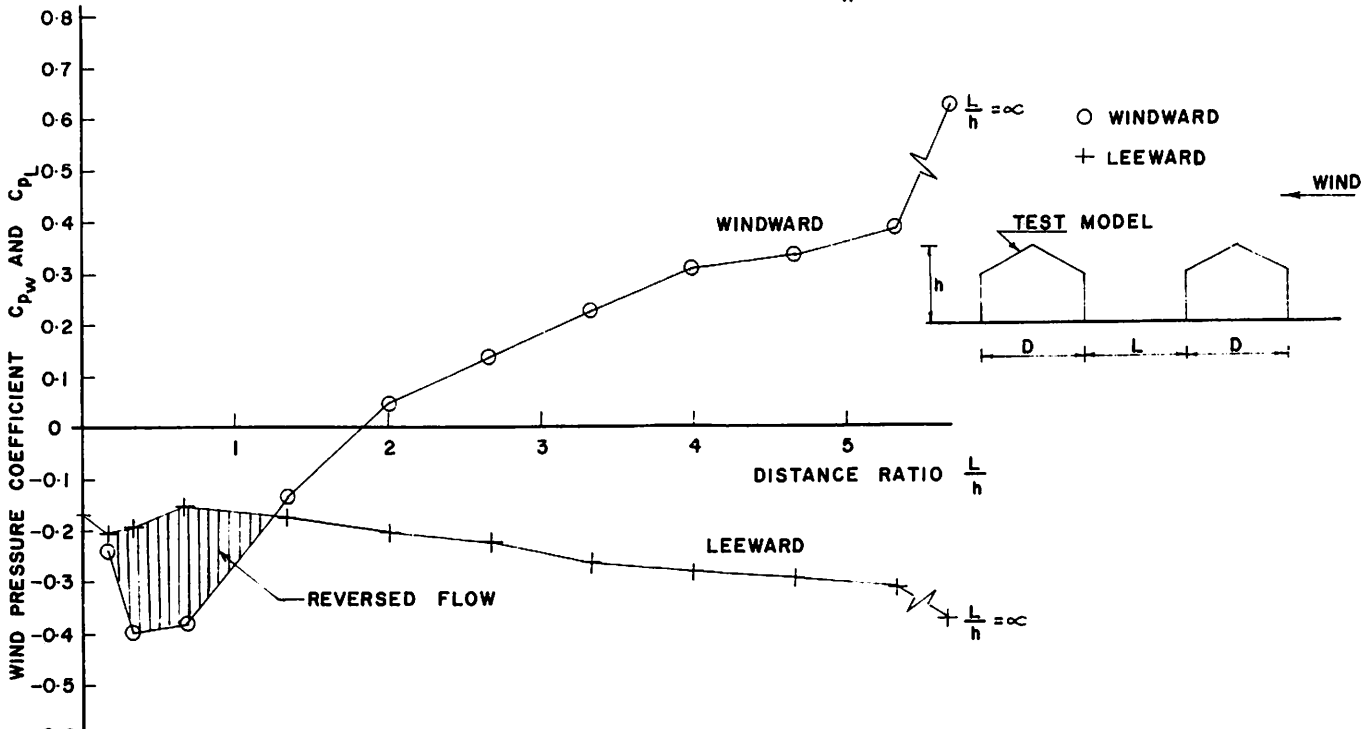

FIG. 1. VARIATION OF PRESSURE COEFFICIENT WITH DISTANCE RATIO. MODEL TO LEEWARD.

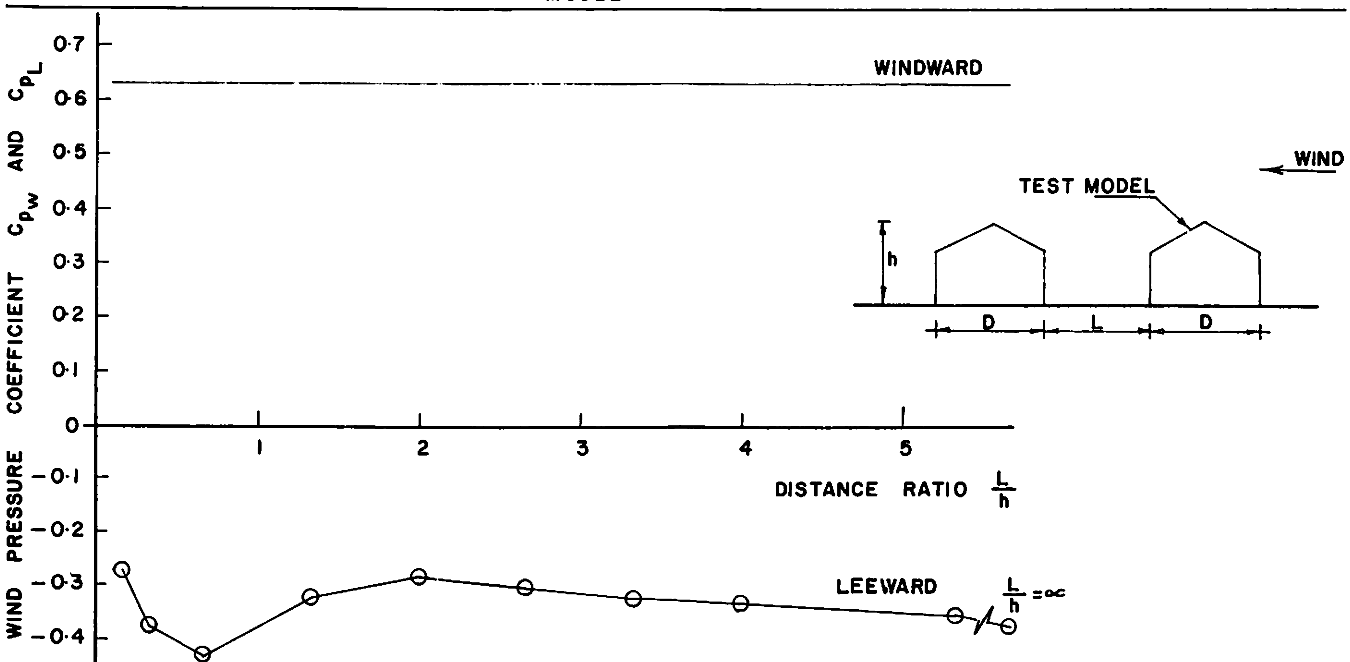

FIG. 2. VARIATION OF WIND PRESSURE COEFFICIENT WITH DISTANCE RATIO. MODEL TO WINDWARD.

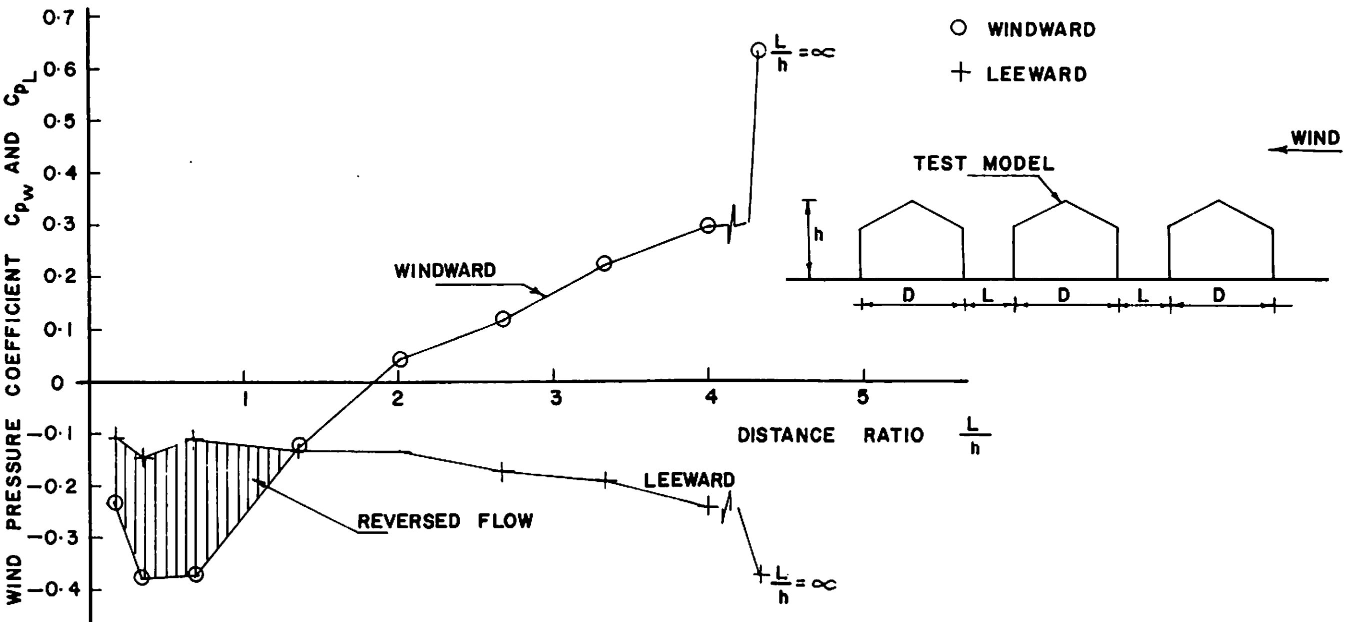

FIG. 3. VARIATION OF WIND PRESSURE COEFFICIENT WITH DISTANCE RATIO. MODEL IN CENTRE.

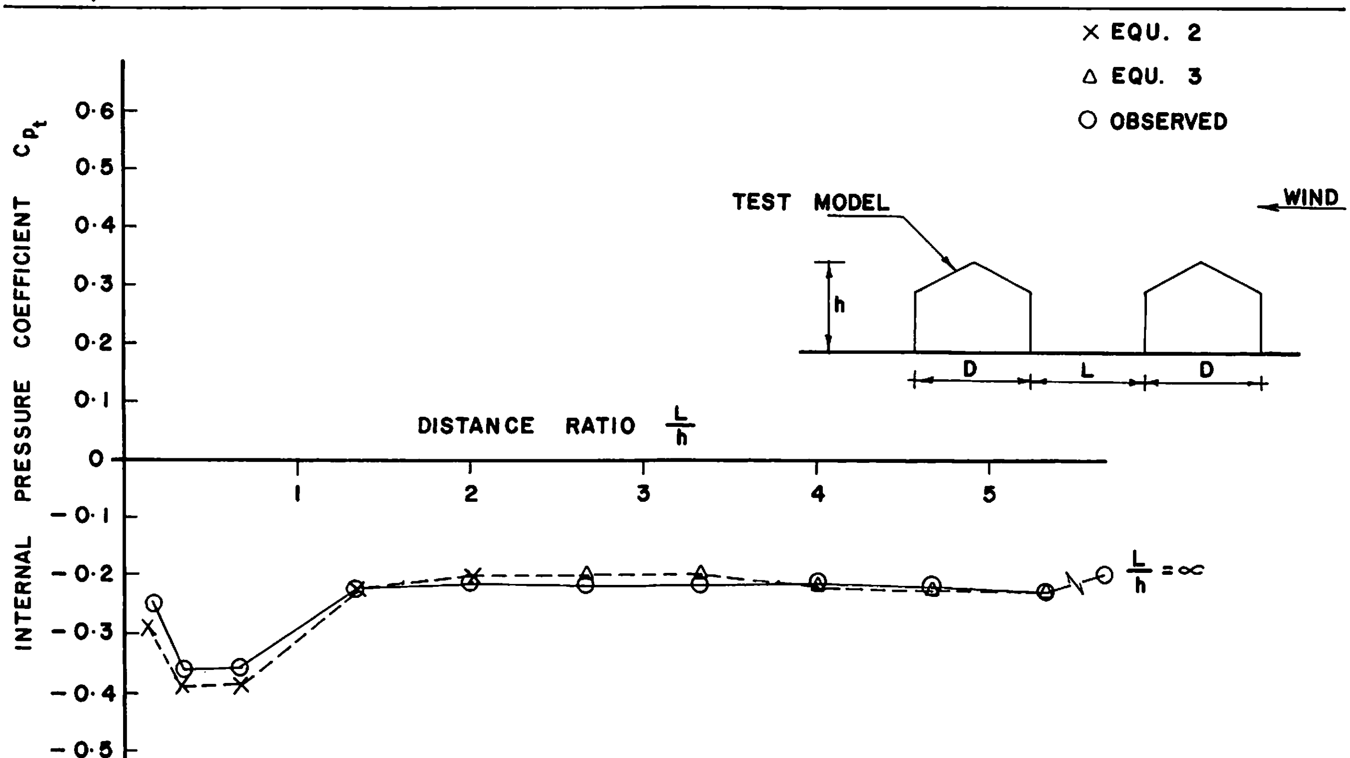

FIG. 4. VARIATION OF INTERNAL PRESSURE COEFFICIENT WITH DISTANCE RATIO. MODEL TO LEEWARD.

6. The computed internal pressures were obtained using the equations.

$$C_{p_t} = \frac{2\Delta p_f}{V_h^2} + \frac{V_h^2}{32\Delta p_f}\left(C_{p_W} - C_{p_L}\right)^2 + \frac{1}{2}\, C_{p_W} + C_{p_L} \quad ..(1)$$

and

$$C_{p_t} = \frac{1}{2}\left(C_{p_W} + C_{p_L}\right) \pm \frac{1}{2}\left[\frac{-64\Delta p_f^2}{2V_h^4} - \frac{16\Delta p_f}{V_h^2}\, C_{p_W} - C_{p_L}\right]^{\frac{1}{2}} \quad ..(2)$$

(see ref [1])

In fig 4, 5 and 6 the internal pressure of the tested building showed greater variation at small separation ratios than when the ratio was increased to a value greater than 2. During a separate test, when the tested building was used in isolation at the same rate of air extraction Q_f, it was found that the fan dominated the flow direction through the building for wind speeds of less than 4 m/sec. (ie air was flowing into the building through both openings). Above this level of wind speed, flow reversed direction through the leeward opening. This was not the case when another building was sited to windward of the tested building.

In the arrangements in fig 4 and 6 although the speed of wind was much higher than the 4 m/sec mentioned above (ie 8.4 m/sec) the flow direction through both windward and leeward openings was dominated by the fan for a range of separation $\frac{L}{h}$ between 0.2 and 2. Above this range the flow direction was reversed through the leeward opening. However, in the arrangement of fig 5 the tested model was exposed to the direct effect of wind and therefore the direction of flow through it was dominated by wind rather than the fan for all distances of separation.

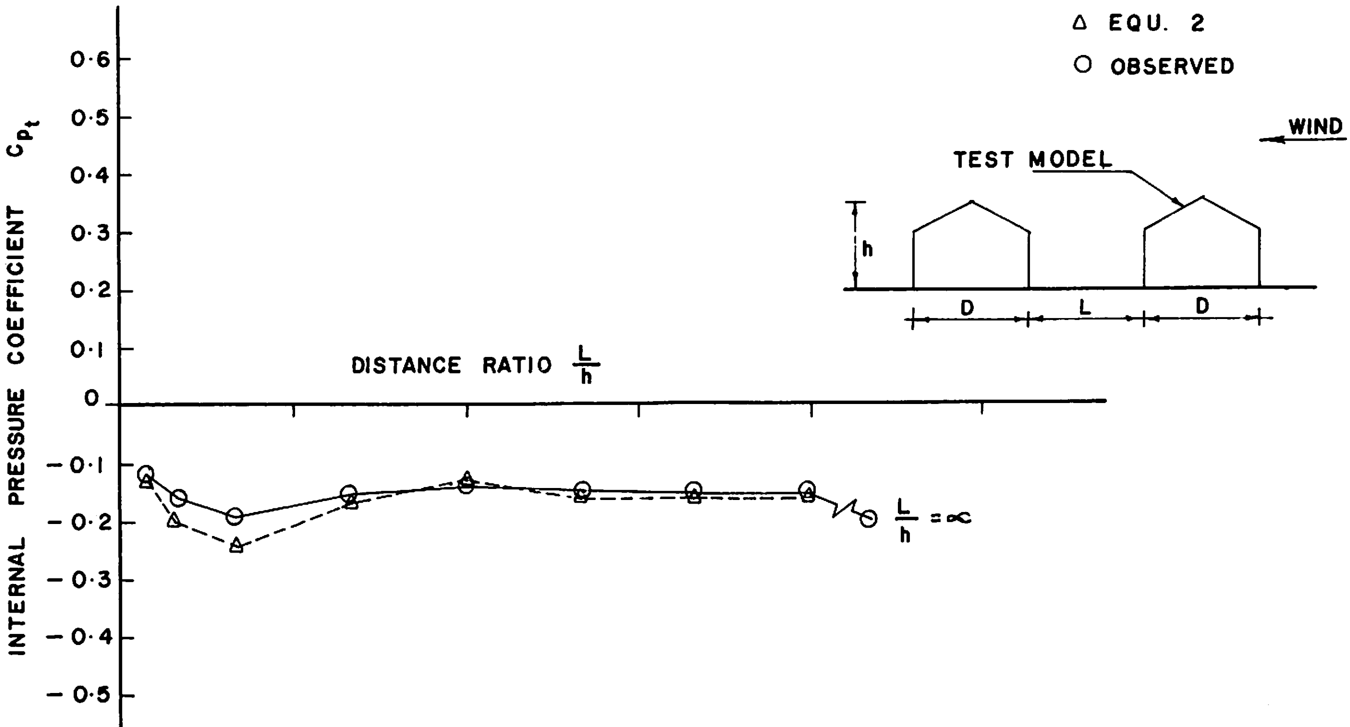

FIG. 5. VARIATION OF INTERNAL PRESSURE COEFFICIENT WITH DISTANCE RATIO. MODEL TO WINDWARD.

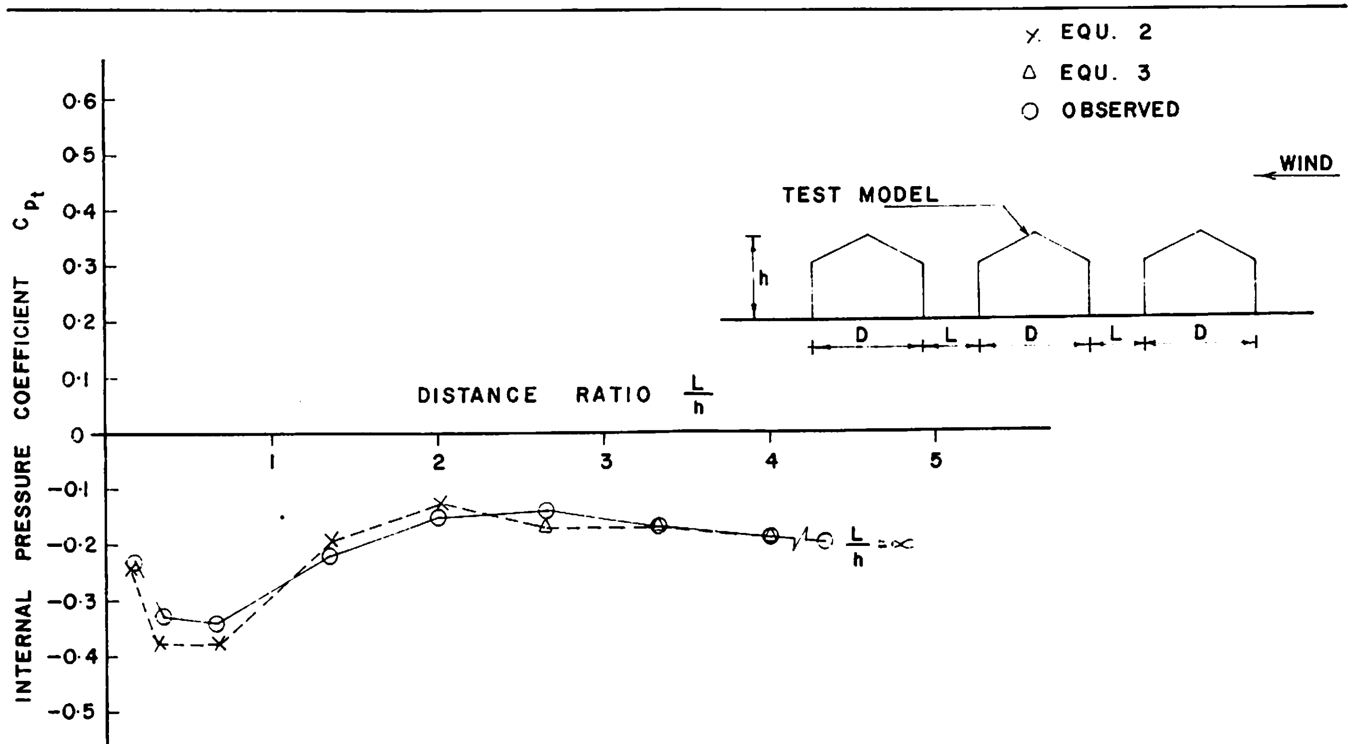

FIG. 6. VARIATION OF INTERNAL PRESSURE COEFFICIENT WITH DISTANCE RATIO. MODEL IN CENTRE.

The internal pressure expressed in N/m^2 (ie not in the dimensionless form as fig 4, 5 and 6) was plotted against the distance ratio $\frac{L}{h}$ as shown in fig 7, 8 and 9. The pressure Δp_f set up in the building due to the fan in still air conditions was also plotted in the same figures. The difference between the two pressures, indicated by an arrow at each interval of separation tested, represents a pressure R_t exerted on the fan and which had to be overcome in order that the design rate of air flow could be obtained (the back pressure caused by the wind on the fan is not considered here but it can be taken in addition to R_t).

In fig 7 the pressure R_t reached its maximum value at $\frac{L}{h} = 0.3$. Referring to fig 1 it can be seen that at this separation between the two buildings the sum of wind pressures on the tested model reached the highest "negative" value. Increasing the ratio $\frac{L}{h}$ beyond 0.3, the windward side became more exposed to the wind effect and accordingly the wind pressure on this side increased. Since the rate of increase of wind pressure on the windward side was higher than the rate of decrease on the leeward side, then the resistance R_t decreased with the increase of the distance of separation. It reached its minimum value at $\frac{L}{h} = 2.7$. It increased again and would finally have reached the same value as in the situation where the building existed in isolation ie at $\frac{L}{h} \longrightarrow \infty$

If the ventilation were achieved by a pressurised system, the resistance R_t would decrease when the sum of the wind pressure on

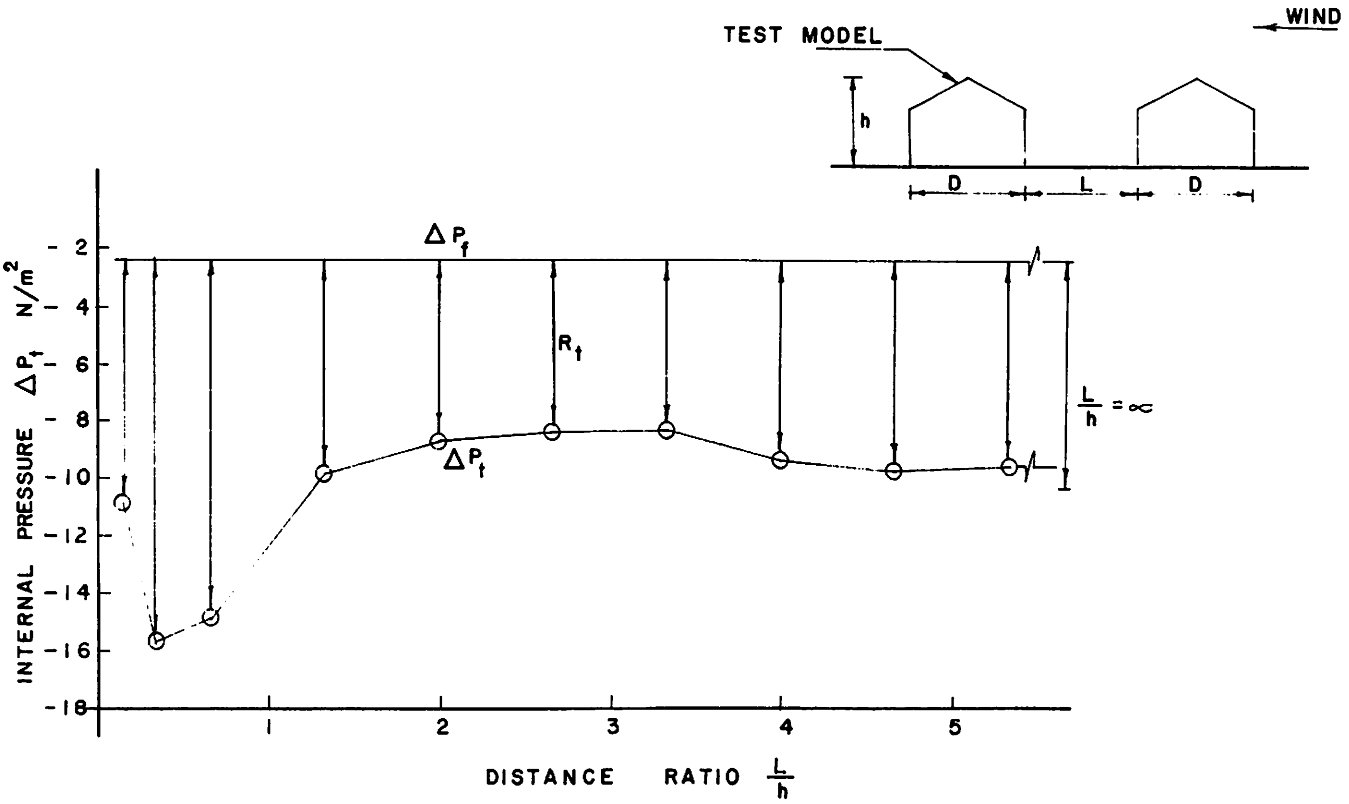

FIG. 7. VARIATION OF INTERNAL PRESSURE AND RESISTANCE R_t ON FAN WITH DISTANCE RATIO. MODEL TO LEEWARD.

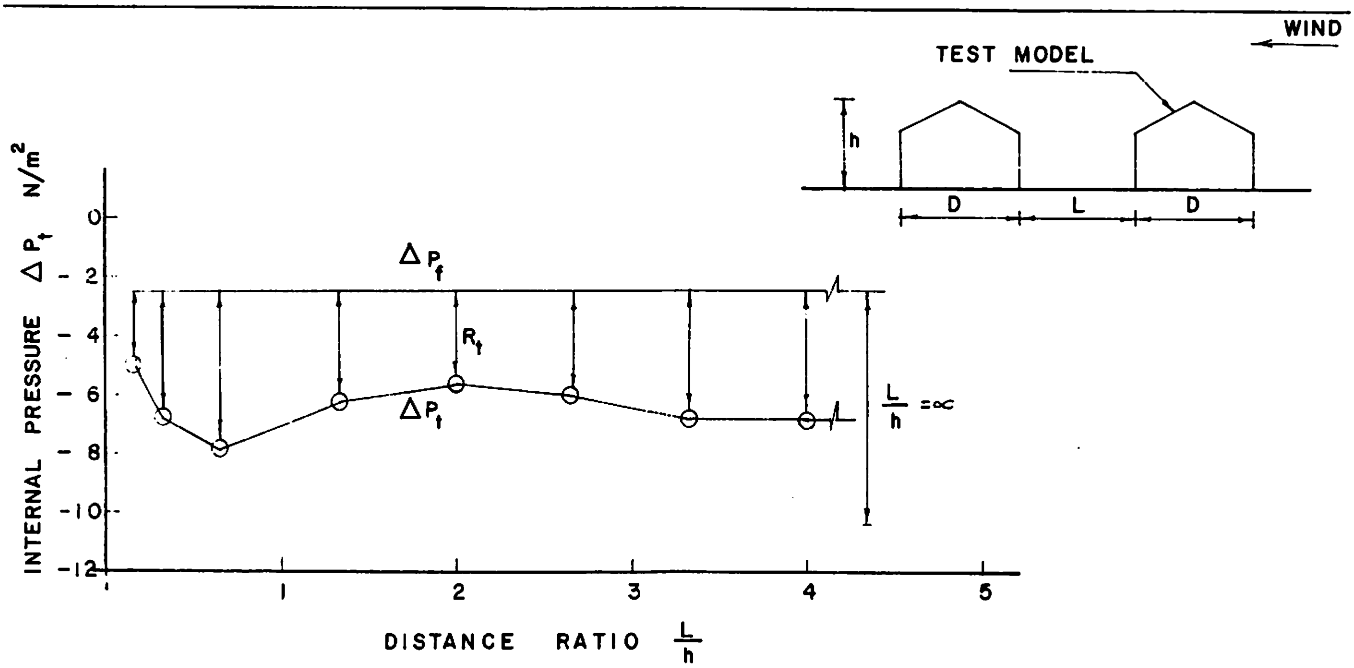

FIG. 8. VARIATION OF INTERNAL PRESSURE AND RESISTANCE R_t ON FAN WITH DISTANCE RATIO. MODEL TO WINDWARD.

the openings decreased. Thus the minimum value for R_t in this case could be obtained at $\frac{L}{h}$ = 0.3 ie the contrary to the extraction system.

Similar patterns of results to those shown in fig 7 were also obtained in the cases of fig 8 and 9. The resistance R_t in all cases of separation in fig 8 are lower than the corresponding values in the other two cases of fig 7 and 9. Generally in the three figures, the resistance R_t reaches its minimum values at $\frac{L}{h}$ of approximately 2.

Summary and Conclusions

The effect of an adjacent structure on a fan ventilated building was examined using models exposed to a modelled air stream in a wind-tunnel. The tested model was sited with various separation either up stream or down stream from another building of identical shape, or in the centre of the space between two identical buildings. Wind pressure on the building, internal pressure and resistance set up on the fan due to wind effect were plotted against the ratio of separation distance to building height. Measurements were made only for a wind direction at right angles to the long axis of the building. It was concluded that

1 The leeward building is affected to a greater degree than the windward building.

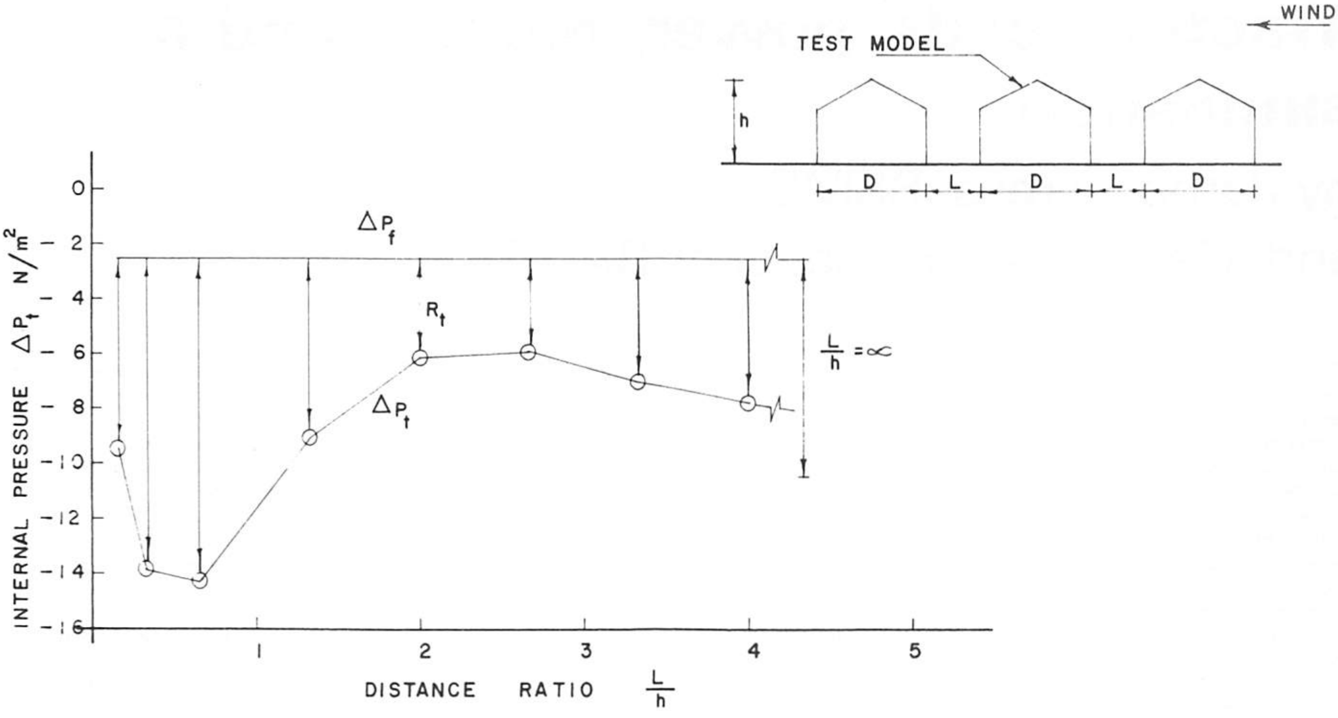

FIG. 9. VARIATION OF INTERNAL PRESSURE AND RESISTANCE R_t OF THE FAN WITH DISTANCE RATIO. MODEL IN CENTRE.

2 If a building is equidistant between two similar buildings, this gives approximately the same results as when there is a building only on the windward side.

3 Close proximity of a windward building increases the "negative" wind pressure on both sides of the shielded building and accordingly the resistance R_t on extraction fans is increased.

4 For an extraction system in buildings with equal openings on both sides, a separation space of two to three times the height between the buildings in the windward direction is the optimum having regard to resistance R_t.

5 For pressurised systems in buildings in close proximity to another building in the windward direction, there is a decrease in the resistance R_t due to the "negative" wind pressure on both sides of the shielded building.

It should be pointed out that this study was limited to a given set of parameters, and the results should not therefore be generalised for all cases of buildings without careful consideration. Other factors such as building orientation, shape and dimensions and the gradient of the approaching wind velocity profile must be considered.

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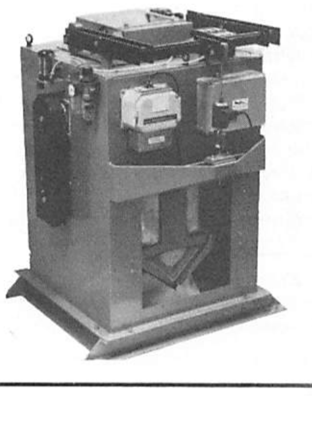

Tractor trends, power, money – and a simulation

by James Kress BSME and George Koenigsaecker BA MBA

PERIODICALLY, various persons become motivated to speculate upon the coming world of tractors. Trend lines are plotted for the past and warped into the future. A rationale is presented, supported by graphs, charts, pictures, cartoons – if necessary, and a substantial bibliography. More recently the resources of the almighty computer have been invoked to render its irrefutable judgments. Such is the likely substance of technical papers on this subject.

Recent worldwide economic upheavals make it particularly timely to critically look at current farming practices and once again speculate about the future. This paper considers briefly, trends in tractor engines, transmissions, hydraulics and operator environment, relating these areas to economic matters. The subject of tractor power, however, is treated in greater detail, including an illustration showing the comparative functional and cost performance of a small and a large tractor under simulated conditions.

Large farm equipment companies are by economic necessity, becoming worldwide, or at least multi-national in scope. However, the transition from regionally-oriented designs to worldwide designs takes time.

Traditionally, tractor design has been influenced primarily by conditions prevailing in the country of manufacture. But average conditions vary from one country to another, with varying topical and climatic conditions, differing agricultural practices, legal requirements, and social factors. Fortunately in North America there is a wide base of differing conditions, – in soils, terrain, agricultural practices and farm size. Despite this situation, there remains sufficient differences between countries so that accommodation of all requirements into a single design is impossible as well as uneconomical. Therefore, worldwide design requirements are likely to be satisfied in the future with adaptations to specific requirements, possibly through the use of differing component modules. Suffice it to say that all major farm equipment companies are struggling with the detail problems.

Tractor trends

Recognising the dangers of engaging in prognostication (sometimes called planning), it is still a healthy exercise for companies, and for farmers. Tractor trends are discussed below for major component areas. Finally, the question of tractor power is addressed, especially in relation to cost and functional factors.

Engine trends

The current energy "crunch" along with more stringent requirements for noise and emissions control, have caused recent attention to be focussed upon power plants. Out of the mass of recent technological studies a rather concrete prediction emerges. The diesel engine will be the leader in tractor power for many years. Although introduced late last century, much of its potential is just now starting to be realised. Higher power density (high power in a small package) is being achieved by turbocharging and "intercooling". Higher torque reserve, better acceleration characteristics and better fuel economy are being achieved by optimisation of many design factors. Optimisation is being aided by computer modeling. The control of noise and emissions represent further challenges, but these too are being accommodated in new designs.

The key to many solutions lies in the deliberate dedication of substantial time and money for the required technological advances. Hasty solutions may be counter-productive, causing a deterioration in one aspect while favouring another. One fortunate aspect is that the trend to high power density engines retards the rate of engine cost increase.

The diesel engine requires a specific petroleum fuel which represents a small segment of the total spectrum of different fuel types. Largely because of this circumstance many organisations and individuals are looking at alternate engines using a variety of fuels. Work on the multi-fuel gas turbine engine has progressed slowly. Large scale production applications await the realisation of high temperature materials to make the turbine competitive with the diesel in thermal efficiency.

External combustion engines are also being investigated. The multi-fuel Stirling Cycle engine, with reciprocating components, similar to the diesel engine, also has the potential for high thermal efficiency and good noise and emission characteristics. Like the gas turbine, achieving this high efficiency awaits the development of high temperature materials.

Transmission trends

The subject of future tractor transmissions has in the past been distinguished mostly by the volume of published material. While adding to this volume one must make note of the growing desire for more convenient transmissions. In a basic tractor that costs – say £5000, the farmer expects more than primitive shifting capability. For the more deluxe transmissions, many farmers will pay an additional increment of 5 to 10% over the tractor basic price.

Transmission types are discussed briefly below in relation to their present and projected positions.

Collar shift or clash gear transmissions

Many tractors use this type transmission. These transmissions are characterised by simplicity, with accompanying low cost and high operating efficiency. Customarily the operator stops to shift. However, some have become expert at on-the-go shifting and exhibit their capabilities at the least excuse. One must note a diminishing trend for this transmission type both in Europe and North America.

Synchronised transmissions

Transmissions which are synchonised for all or part of their gear ranges remain popular with good justification. Shiftability is enhanced over the collar shift or clash gear types previously mentioned, particularly where the inertia of the moving machine predominates over retarding forces, such condition occurring, for instance, at transport speeds. The modest cost, reasonable performance, and high efficiency of this transmission type leads to the prediction that it will continue in popularity, particularly in Europe.

Power shift transmissions

With this transmission, the operator can shift gears under load without declutching. The most popular tractor transmissions in the States are now of the power shift hi-lo variety combined with collar shift or synchronised transmissions. On the other end of the scale are the "full power shift" transmissions having the capability of shifting under load between any gears without declutching. Shifting is usually enhanced to the degree that power shifting replaces synchronising or clash gear shifting, and to other factors such as number of speeds and suitability of controls. Although power shift transmission efficiency may theoretically suffer slightly compared to previously mentioned types, productivity may actually improve and the farmer can shift conveniently without fatigue. Looking ahead one can easily predict the use of more power shifting in North America especially for the larger

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Presented at East Anglian Branch of The Institution of Agricultural Engineers on 13 November 1975.

tractors. High retooling costs for any major tractor component tend to limit drastic design changes both in Europe and in North America.

Infinitely variable transmissions

The transmission designer's dream is coming closer to fruition. But for general agricultural tractor usage, the application of infinitely variable transmissions is still being impeded by factors of cost and performance.

Hydromechanical (combination of hydrostatic and mechanical) transmissions have great aesthetic appeal since they can potentially combine some of the efficiency advantages of gear transmissions with the infinitely variable speed selection of the hydrostatic transmission. However, no known tractor manufacturer has yet come up with the magic combination of performance at a reasonable cost. Hydrostatically-propelled tractors of the size provided by International Harvester in North America appear advantageous where much of the power is routed primarily to the power takeoff or where frequent speed or direction changes are necessary. For the future, hydromechanical transmissions appear feasible for increased usage especially if their controls can be merged with those of the engine for optimisation of fuel economy and productivity.

Hydraulic system trends

Farmers have become accustomed to the muscle and convenience provided by present day hydraulic systems. Hydraulic applications could be classified as intermittent or as continuous usage. A brief discussion follows:

Intermittent applications

Lift systems, remote cylinder usage, power steering and power brakes are examples. Their capacities basically correlate with tractor power. This trend is expected to continue for the future. However, an increasing number of intermittent applications are being discovered for both tractor and implement, leading to complications for the total system. Increased efforts are expected in the future to provide increased reliability and better control.

Continuous applications

Low power, continuous-running hydraulic motors are presently being used on various implements. While many potential applications exist, their usage is limited by compatability problems with tractor systems. Efforts are being made through standards organisations to co-ordinate efforts of manufacturers. Increased applications will depend largely upon the response by manufacturers to the increased demands for continuous remote hydraulic power.

The average working pressure of hydraulic system is continuing to increase, reflecting the economy of using smaller components.

More efficient hydraulic systems are foreseen with the objective of more closely matching the energy required for loads with energy supplied by the pumps.

The benefits derived from draft and position responsive hitch systems are well known. Further improvements in hitch control are foreseen. Dramatic improvements are needed in the coupling of equipment however, for increased safety and convenience. These improvements are likely to occur in an evolutionary manner due to the combined effects of cost and functional problems, and the large variety of existing equipment.

Operator environment trends

The farmer's satisfaction with his tractor depends greatly upon his operating environment. This includes the obvious physical characteristics of his tractor as well as the more subtle aspects of tractor and implement control. Long before the enactment of legal restraints the major tractor manufacturers have taken the initiative in responding to real needs. Substantial effort is being made in all major areas as discussed below:

Legal requirements

An orderly progression is underway both in Europe and North America to achieve needed improvements in noise and emission control, rollover protection and ride improvement. The problems are often more severe with the larger tractors.

Ride improvement

Aside from possible future legal requirements manufacturers are voluntarily proceeding to improve ride. A potential manufacturing economy exists in providing small high power tractors operating at increased field speeds as compared to large tractors of the same power operating at conventional field speeds. Speed increases have been and will likely continue to be evolutionary, however. Traditional farming practices, the necessity of operating future tractors with existing implements, widely varying terrain and the deteriorating tractor ride at higher speeds all tend to restrain dramatic speed increases. With regard to ride improvement, it appears within the manufacturer's technical capability to substantially improve ride at higher speeds. Time will be required to do this economically.

Instruments and controls

The emerging world of electronics is opening up a fascinating array of potential tractor applications. The greatest near term potential appears to be in the area of instrumentation and display. The vital functions of the tractor and the implement could be measured and displayed to the operator in a greatly improved manner compared to present day instruments. Progress towards this goal will likely parallel that of the general automotive industry, however. A longer term potential exists in the merging of electronic brains with mechanical muscle to perform the various tractor control functions. While exceptions exist, progress towards this goal is constrained by both functional and economic matters.

Operator enclosure

Well-designed cab structures have until recently been unavailable. A physical environment is now available on most large tractors providing some degree of temperature, dust and noise control. This improvement permits the operator to concentrate more upon the job at hand. The future inclusion of cab improvements on smaller tractors is foreseen.

Power trends

One can recall several years ago the predictions of increased power for passenger cars in the States. But the combined impact of the energy crisis and inflation suddenly deflated the trend line – and the prognosticators. However, presently there is little indication that either of these factors is greatly affecting tractor trends in Europe or North America. Other factors predominate, such as the changing nature of farm size, labour costs, availability of capital, custom farming, timeliness and social considerations.

Fig 1 shows the plot of average tractor power percentage increased from 1950 to 1970 for the EEC and the United States[1]*. Increases for the EEC are seen to have lagged behind those in the US but are increasing faster now that during the 1950's and 1960's.

Fig 1 Percent power growth – USA and EEC

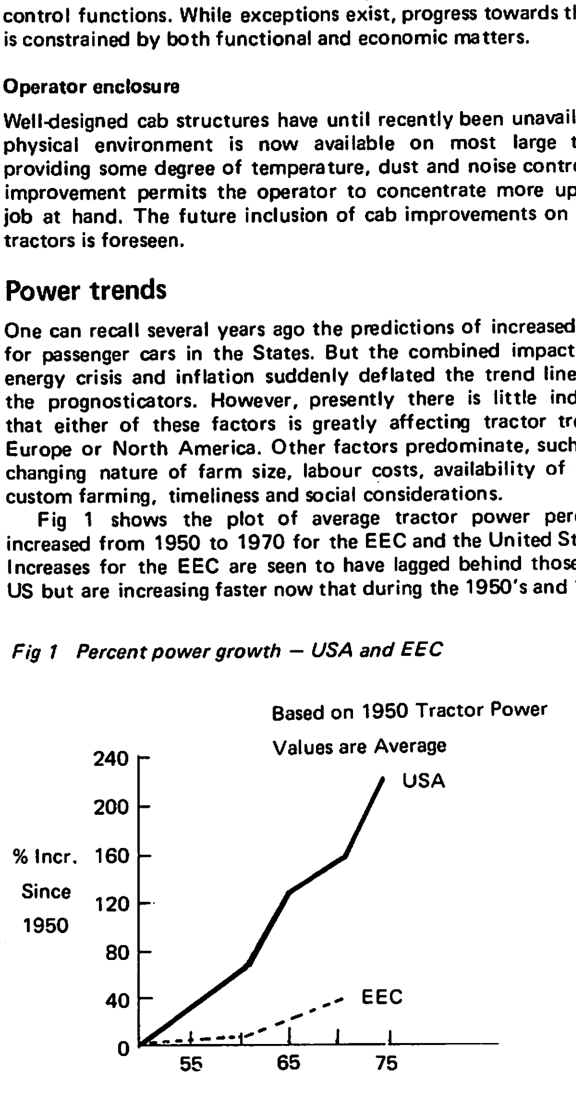
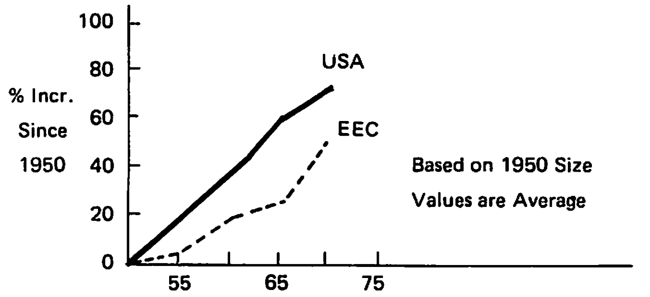


Fig 2 shows the plot of average farm size percentage increase for Western Europe and for the United States[1]. The EEC farms, while starting from a much smaller average size, have been consolidating at about the same rate as US farms. This increasing average farm size supports the trend to higher tractor power levels.

Trend curves are based upon averages, but the typical farmer is anything but average. He must turn to other sources for aid in making a tractor buying selection. He may find that he is overly-aided in reaching a decision but under-aided if the decision later turns sour.

→ *page 82*

Fig 2. Percent farm size growth — USA and EEC



The dealer perhaps exerts the greatest influence and will rather promptly suggest a specific colour, size, and type of tractor. Farm journals may offer less prejudiced suggestions. Computer programmes are available to assist in making the selection. Subtle persuasion is exerted by the farmer's neighbours. The combined effect of all of these along with the farmer's own preferences and intuition cause him to reach a buying decision.

Similarly the manufacturer must also decide which machines to build. He is likewise influenced by farmers and dealers, various publications, bankers, governmental pressures and inhouse specialists. A goodly sprinkling of intuition is also used, preferably called judgement. From this the manufacturer must provide appropriate machines in a competitive market. A "cost squeeze" always exists for manufacturers as well as for farmers. This is a frustrating period for both.

What happens when you increase tractor power?

The farmer, quite correctly, may wonder why manufacturers always seem to increase power on new models. In the face of making a tractor buying decision, it is well to review the functional and economic effects of increasing tractor size. Some of the factors are considered below.

Timeliness

Assuming that a large tractor replaces a small one, the larger tractor obviously completes a given task more rapidly. A more optimum time period may be selected and the tractor will become available for other usages. Perhaps just as obviously, the larger and more expensive tractor will remain idle for a longer period unless it is indeed used for other operations. Where one tractor replaces two smaller tractors, the timeliness for performing operations may not be affected. Other combinations for tractor replacement are possible.

Dimensional considerations

The higher power tractor is likely to be larger in most of its dimensions which can cause problems. However, many manufacturers compensate for such dimensional disadvantages, such as loss in manoeverability, by providing more deluxe features in the area of transmissions, controls and operator environment. Visability may likewise suffer but only to a slight degree. But implement width usually increases linearly with tractor weight. Operating and transport problems have to date been satisfactorily solved.

Noise

Noise on larger tractors differs in quality and may, or may not be more intense. While engine noise may reduce, transmission noise may increase. Manufacturers have been able to cope with noise problems, starting with the design, by control of noise at its source, by restricting its transmission and by isolating the operator.

Soil compaction

Larger tractors usually lead to greater soil compaction[2]. For instance, if a tractor's dimensions are increased to cause a 100% increase in power and weight, the tyre area contacting the ground has only gone up about 60%. This follows since the tractor has been increased in size by three dimensions, whereas the tyre "footprint" has only increased in two dimensions. The logic may be developed, therefore, for providing very small tractors with four-wheel drive with the front tyres being smaller than the rear, and for large four-wheel drive tractors with equal size tyres. Dualing tyres has become increasingly popular in North America, to reduce slippage and compaction. In fact, some of the large four-wheel drive tractors are operated with spaced duals for minimum compaction during cultivation of row crops. Improved tyre performance is being pursued. The use of radial tyres appears particularly beneficial from soil compaction and traction aspects. Other characteristics of the radial tyre need further investigation.

Cost per acre

With a given type of tractor the cost per unit of power usually goes down with increasing power. For instance, the weight of a gear may be doubled to obtain twice the power, but the material cost has probably not doubled and the machining costs are certainly less than double. In addition, labour costs for operating the larger tractor are likely to be equal or only moderately higher. However, the larger vehicle has cost more, naturally resulting in higher interest and other costs.

The interaction of all the above cost factors and the vehicle performances make it difficult for the manufacturer or the farmer to objectively assess the merit of different tractors.

The vehicle mission simulation programme

Recognising the complex nature of estimating the functional and cost performance of different vehicle-implement combinations, engineers at the Technical Centre of Deere & Company at Moline, Illinois, put together a comprehensive computer programme[3]. The programme considers cost and performance factors for both vehicle and implement in completing a prescribed work cycle or mission. Fig 3 lists the major inputs and outputs of the programme. These are summarised briefly below.

Tractor

The tractor is described according to its dimensions and weight distribution. The performance of each of the various components which generate, absorb or transmit power is also described. The customer cost for the tractor, tyre replacement, fuel, and other items are inputted.

Implement

The implement is likewise described in dimensions, weight and customer cost. Dimensions include a description of the attachment to the tractor.

Work cycle (mission)

The tractor and implement are assigned a specific work cycle or mission, usually consisting of several differing segments. The individual segments contain variations in terrain including its length, slope and soil strength as measured by a cone penetrometer. In addition, the operating depth for the implement and a coefficient relating the implement's low speed draft resistance are assigned. For the tractor a maximum speed is specified. Certain rules are applied to running the mission such as limiting the maximum acceleration of the tractor, specifying a time to complete shifting and indicating in which gears the front wheel drive will be used, if any. It should be recognised that the total system described is rather complex. At least a medium-sized computer is required.

An illustration of programme usage

An example of the programme's use has been made which may be pertinent to the area of East Anglia in England. A comparison is made of a Deere 2130 Tractor with a 3-furrow plough and a Deere 4430 Tractor with a 6-furrow plough, both operating in a 40-acre field. Cost data has been obtained which should be reasonably valid for this area*. Other manufacturers' tractors could have been used, however, the data was understandably easier to obtain for in-house tractors. A Deere power front wheel drive is engaged for all runs. Performance values for front and rear drives were assigned based upon experience.

Typical tyre equipment has been selected for both tractors for in-furrow ploughing. The tractors are ballasted for heavy draught conditions.

For the 2130 a Hi-Lo transmission is used with operation limited to high and low ranges of gears 3, 4, 5 and 6. For the 4430 a Quad-Range transmission is used with operation limited to the

**For the illustration, a money conversion rate of 2.1 dollars per pound sterling was used.*

Fig 3 summary of input and output information

Inputs

Tractor — Functional Information
- Dimensions
- Weights and weight distribution
- Tyre dimensions and tyre performance
- Type of drive (2WD or 4WD)
- Engine performance
- Transmission performance
- Work hours per year
- Expected life of engine, transmission, tyres and balance of tractor

Tractor — Cost Information
- Total tractor cost to farmer
- Downtime cost
- Interest, insurance, taxes, storage
- Operator wage
- Maintenance costs

Implement
- Type
- Dimensions
- Weight
- Cost to farmer
- Maintenance cost
- Work hours per year
- Life

Mission
- For each segment of mission, distance, slope of terrain, draught coefficient, soil coefficient and operating depth

- Information on how to run mission

Outputs

Functional Information — For Each Segment:
- Gear used
- Axle torque and speed
- Engine speed and power
- Traction, rolling resistance and net pull per wheel
- Lateral force per wheel
- Normal force per wheel
- Slip per wheel
- Sinkage per wheel
- Forces at front axle hinge
- Elapsed time and distance
- True ground speed

Summary of Functional Information
- Time to complete work cycle
- Distance travelled
- Production (acres)
- Production rate (acres/hour)

Summary of Cost Information
- Wages
- Tyres
- Lubrication
- Depreciation
- Maintenance
- Fuel
- Carrying charge
- Downtime cost
- Total cost (total of above)
- Cost rate per hour
- Cost rate per acre

four gears of its "B" range. Shifting delays were assigned to both tractors for specific gear changes. During ploughing the tractor operates in the highest gear possible.

Two different ploughs are simulated for the 2130. A 13 in 3-furrow integral plough costing £557 is used in a rectangular ploughing pattern; a 13 in 3-furrow reversible plough costing £1130 is used in a conventional serpentine ploughing pattern for reversible ploughs. For the 4430 a 12 in 6-furrow semi-integral plough costing £1700 is used.

The 2130, equpped with a Deere OPU (Operator's Protection Unit) and power front drive, was assumed to cost £6063. Likewise the 4430 equipped with Sound-Gard body, also with power front wheel drive, was assumed to cost £11506.

The above information is summarised in fig 4 which also indicates the combination of conditions for the various simulated runs. Additional inputs are recorded in fig 9 at the end of the paper.

Fig 4 Major inputs for simulation

Run No.	Traction Cone index lb/in^2	Condition	Plough	Ploughing pattern	Costs (Pounds Sterling) Tractor	Imple.
2130 Tractor						
1	150	Good	3-Fur.	Non-	£6063	£557
2	100	Fair	13in	Revers.		
3	70	Fair	Integral	Plough		
4	150	Good	3-Fur.	For		£1130
5	100	Fair	13in	Rev.		
6	70	Fair	Revers.	Plough		
4430 Tractor						
7	150	Good	6-Fur.	Non-	£11506	£1700
8	100	Fair	12in	Reverse		
9	70	Fair	Non Rev.	Plough		

Work cycle

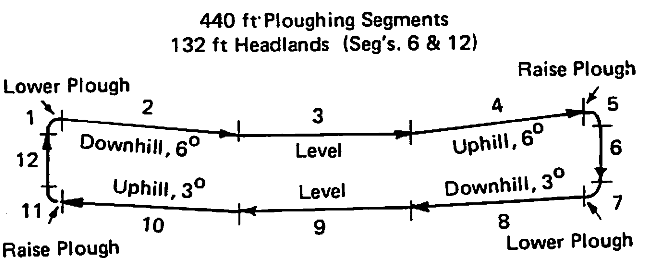
An identical 40-acre square field was selected for the mission of both tractors. For non-reversible ploughing runs the field was laid out in rectangular segments as shown in fig 5A with 132 ft average headland length (Runs 1 through 3 and 7 through 9). Ploughing depth was assumed to be 8 in for all runs and the specific low speed draft resistance was 8 lb/m^2 for all ploughs.

As noted previously, the 2130 was assumed to be alternatively equipped with a reversible plough. To take advantage of this, the 2130 was also evaluated with ploughing cycle eliminating headland segments 6 and 12. This course is illustrated in fig 5B and recorded in Runs 4 to 6. Soil conditions are listed for different runs as being in a "good" or "fair" range, corresponding to cone indices of 150 for good, and 100 and 70 psi for fair.

Results

It is emphasized that simulated performance has been restricted to the given sets of inputs and assumed conditions for the purpose of illustration. While the results are believed to be essentially valid for

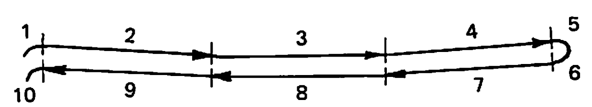
Fig 5A. Ploughing cycles



Rectangular course for non-reversible ploughs

Fig 5B. Ploughing cycles

Note: Straight headland segments are eliminated — otherwise course same length and slope as rectangular course



Serpentine course for reversible plough

these conditions, the complexion of the results would change in a comprehensive study or one in which certain components were optimised.

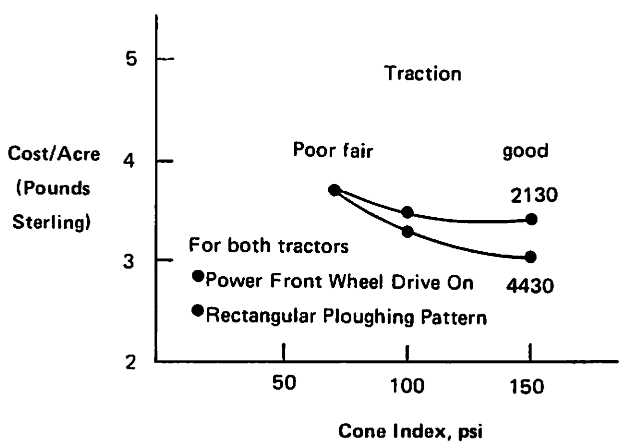
The productivity and cost rates are tabulated in fig 6 for all runs. Several observations may be made:

1. The larger tractor has a lower cost rate (£/acre) particularly under good traction conditions. Figure 7 shows a plot of the cost rate as a function of traction conditions. The convergence of the two tractor plots at about 70 psi cone index reflects higher slippage and sinkage of the 4430 under the assigned conditions. The generally lower cost rate of the larger tractor was undoubtedly influenced by the further assumption of 600 hours per year for each tractor and 200 work hours per year for each implement.
2. The larger tractor has a much higher production rate corresponding basically to its higher engine power. Also shifting between most gears is assumed to be somewhat faster for the larger tractor.
3. For the 2130 the use of the reversible plough resulted in about 10% increased productivity as compared to the 2130 with an integral plough, in their assumed ploughing patterns. This percentage increase would have diminished if longer ploughing segments and/or shorter headland segments had been used. Since the reversible plough was assumed to cost about double that for the integral plough, there was more than a compensating effect for the increased productivity. This resulted in a small economic advantage for the 2130 non-reversible plough runs (Runs 1 to 3) as compared to reversible plough runs (Runs 4 to 6).

Fig 6 Summary of results

Run No	Ploughing pattern	Traction Conditions: Good (150 lb/m^2 Cone) £/Acre	Acre/h1	Fair (100 lb/m^2 Cone) £/Acre	Acre/h1	Fair (70 lb/m^2 Cone) £/Acre	Acre/h1
2130	Tractor						
1	Non-	3.28	1.46				
2	Revers.			3.47	1.38		
3	Plough					3.77	1.27
4	Revers.	3.44	1.57				
5	Plough			3.59	1.51		
6						3.99	1.36
4430	Tractor						
7	Non-	2.98	3.18				
8	Revers.			3.27	2.98		
9	Plough					3.76	2.52

Fig 7 Cost/acre as traction varies



It is convenient to compare the performance of the different tractor/implement combinations for identical segments of their work cycles. A difficult segment (Segment 4) is illustrated in fig 8 which takes the tractor uphill for 440 feet at a 6 degree slope. Data recorded include dynamic weight, slip, ground speed and total pull. Runs 1, 2, and 3 for the 2130 are compared with Runs 7, 8, and 9 for the 4430.

*Fig 8 Summary of segment 4**

Ploughing Pattern — Non-Reversible Plough

Run No.	Traction Cone Index psi	Cond.	Dynamic** Weight, lb Front	Rear	Avg. % Slip Front	Rear	Ground Speed mph	Total Pull, lb
2130 Tractor								
1	150	Good	2393	7776	2.9	12.9	3.80	4055
2	100	Fair	2345	7812	4.3	20.1	3.48	3970
3	70	Fair	2286	7855	6.2	30.1	3.03	3865
4430 Tractor								
7	150	Good	3320	15968	16.2	13.5	3.94	7940
8	100	Fair	3246	15999	32.5	21.3	3.36	7682
9	70	Fair	3129	16080	39.3	33.7	2.76	7475

*Terrain 6^{o} slope uphill **Weight while moving

The dynamic weight distribution shows the pronounced effects of weight transfer. Whereas the 2130 had weighed 4140 lb. statically on its front end without plough, the dynamic weight is 2393 lb (Run 1) while ploughing. Similarly the rear weight has changed from 4750 statically to 7776 lb while ploughing. Higher capacity rear tyres could have been used.

As expected, slip increases as traction conditions deteriorate, still looking at the uphill segment illustrated in fig 8. For the 2130 rear wheel slip increased from about 13% to 30% while rear wheel slip for the 4430 increased from about 13½% to 34%. It follows that true ground speed also reduces as slip increases. For the 2130 speed decreased from 3.80 to 3.03 mph; for the 4430 speed decreased from 3.94 to 2.76 mph. The total pull also reduces as speed decreases, but to a lesser degree, reflecting the plough's soil resistance characteristic. Pull for the 2130 reduced about 4.7% and for the 4430 reduced about 5.9%.

This simulation illustration has been made to acquaint readers with the growing abilities of manufacturers to predict tractor field performance. No conclusions should be drawn about the relative merits of the two example tractors outside of the context intended here. However, the potential of a larger tractor could well be explored by farmers to determine its value for their specific farming situation.

While it is possible to become overly enthusiastic with the capabilities of such a comprehensive computer programme, it is well to note some of its limitations:

1. Quite predictably the results can be only as accurate as the input.
2. Because of this (Item 1) the programme is more valid for comparisons than for absolute results. This is typical for simulation studies.
3. The tractor's draught responsive hitch system is not considered in the programme. Unless tractors with widely differing systems are compared, this limitation is not important.
4. The fairly massive amount of input and subsequent "debugging" often require substantial effort.

Computer programmes for the farmer

The Programme just described and illustrated is being used increasingly by Deere for its purposes. Several computer simulation programmes are available to US farmers from various organisations for determination of the least total cost machinery system. However, due to the inherent complexity of most computer simulations, it is difficult for the average farmer to follow the logic inherent in the simulated results. As a result, many farmers are reluctant to base hard cash decisions on the programme's results. As a practical alternative, Prof Wendell Bowers of Oklahoma State University has developed two "manual" simulations (one simplified and one somewhat more detailed) which can be worked through by most farmers using only a sharp pencil. In the "simplified" version, "Comparing Costs of Big Tractor Systems" Prof. Bowers develops comparative costs and performance data for different tractor and equipment sets and average horsepower hours/acre required to produce various types of crops [4]. By relating the total horsepower hours per acre requirement to the performance provided by the various tractor and equipment sets, he is able to answer such questions as: How many £/acre do I need to gain as a result of more

→ page 86

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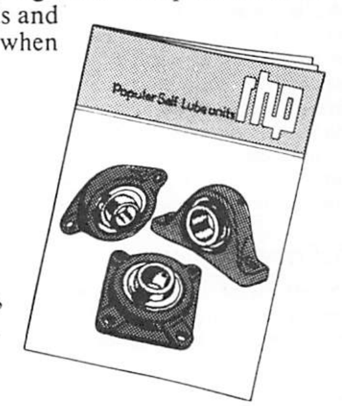

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Continued from page 84

timely operations in order to pay the added costs of the larger tractor systems? Or under what conditions is one large tractor less expensive than two smaller tractors?

In "Selection and Management of Big Tractor Systems" Prof. Bowers develops coefficients of effective horsepower under differing soil conditions and tractor ballast conditions, and relates these to the effective horsepower required for various cropping operations.[5] Using the cost data developed, Prof. Bower's "model" determines tractor selection, tractor ballasting, and implement selection for the lowest cost solution, given a particular farming situation.

Summary

Looking to the future, then, we see continued reliance upon diesel power but with more emphasis on fuel economy and lower cost per horsepower. In transmissions, the synchronised type will continue in popularity although the power shift will steadily gain ground; the newer concepts of infinitely variable transmissions will be of limited appeal until design improvements are made. Hydraulic system pressures will continue to increase to reduce component costs. Additional intermittent and continuous applications will be found. The operator environment – particularly in the areas of noise control, temperature control and ride will improve appreciably due to the pressure for increased operator productivity. Finally new electronic equipment will improve instrument displays and ultimately assist in automatic control of vital functions.

For the near term, the present trend to larger tractors will continue due to their usual lower unit cost of operation on the larger farm units. As a manufacturer, Deere & Company is working to solve the problems of noise, compaction and implement compatibility that are associated with large tractors. In its search for solutions to these problems, Deere & Company's product engineers use various methods, including complex simulation models to develop tractor designs from the point of view of the farm customer who is interested in getting the most productivity from the lowest cost outlay. In the particular simulation runs presented here, we were able to determine that the larger tractor achieved higher productivity under most traction conditions. Although the use of a reversible plough increased productivity, the increased productivity did not compensate for the increased implement cost.

In order to assist you in making the important choices for optimising your equipment, we suggest that the Bower's manual simulation models be considered.

Acknowledgement

The efforts of various people, notably Jim Crosheck, Bernie Romig and Ted Berenyi at the Deere & Company Technical Center, are recognised in expediting the simulation runs.

Fig 9 Additional inputs to simulation programme

	2130 w/Cab & FWD	4430 w/Sound-Gard Body & FWD
Fuel cost	£.24/Imp gal	£.24/Imp gal
Operator wage	£.8/hr	£.8/hr
Residual value of tractor	10%	10%
Percent tractor downtime	5%	5%
Downtime penalty	£3.0/hr	£6.0/h
Interest	14%	14%
Insurance	.60%	.54%
Taxes	.08%	.04%
Tread width	61 in.	80 in.
Flywheel power (DIN) @ Rated engine speed	75 hp	145 hp
Tyre replacement cost	£310.	£586.
Tyre life	2000 h	2000 h
Tractor life	6000 h	6000 h
Engine life	3000 h	3000 h
Implement life	2000 h	2000 h
Implement weight	Integral 1118 lb Reversible 1700 lb	Semi-Integral 2794 lb
Implement work h/yr	200 h	200 h
Tractor work h/yr	600 h	600 h
Tyre size – Front	9.5-24	12.4-24
Rear	13.6-38	18.4-38

References

1 "Agricultural Statistics" (1974) published by the Statistical Office of the European Communities.

2 **Prof Dr. - Ing Walter Sohne and Dipl Ing Hartmut Pietsch** Munich, Ackerschlepper 1974/76, *ATZ Automobiltechnische Zeitschift* 77 (1975) 4.

3 **T Berenyi, R L Pershing and B E Romig** "Vehicle Mission Simulation", SAE Paper 730693, October, 1972.

4 **Prof Wendell Bowers.** Extension Agricultural Engineer, Oklahoma State Univ, Stillwater, Oklahoma, 74074, "Comparing Costs of Big Tractor Systems".

5 **Prof Wendell Bowers.** Extension Agricultural Engineer, Oklahoma State Univ, Stillwater, Oklahoma, 74074, "Selection and Management of Big Tractor Systems".

DEVELOPED for use in hazardous areas, the 'Caretaker' Mark II F Compactor, a flameproof unit conforming to BS 229 Group II and III Gases or B 4683 Part II (Group 2A and 2B) or equivalent to or suitable for use in Zone 1, will handle metal drums, containers, paint tins and aerosols with residual low flash point materials achieving considerable savings of the cost of disposal of the containers. The Compactor can also be employed in a variety of other roles, for example, the collection of valuable metal scrap and of reject components into compacted cubes for recycling.

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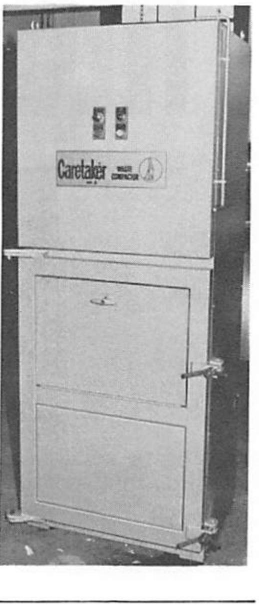

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THE EAST MIDLANDS BRANCH CONFERENCE, SUPPORTED BY THE DEPARTMENT OF INDUSTRY, WILL BE HELD ON TUESDAY 11 JANUARY 1977, AT NOTTINGHAM UNIVERSITY, ON THE SUBJECT OF:

CORROSION IN AGRICULTURE

Members in the Midlands have been mailed, if anyone else is interested please contact:

The East Midlands Branch Honorary Secretary:

E F Beadle TEng(CEI) MIAgrE,
East Midlands Branch Honorary Conference Secretary,
4 Grange Cottages,
Riseholme, Lincoln.

Telephone – Office: 0522 22252 Ext 34.

Report on the first International Congress on Engineering and Foods – held at Boston USA August 9 –13 1976

THIS conference was sponsored by the American Society of Agricultural Engineers with the University of Massachusetts, Amhurst, MA acting as Secretariat. The Institution of Agricultural Engineers was a co-operator.

Some 500 people attended the various sessions and 200 papers were read. These were divided up into:-

Five half day sessions on the Engineering Properties of Food.
Two half day sessions on Food Waste Utilisation and Management.
Two half day sessions on Energy Use and Conservation in the Food Industry.
Eight half day sessions on Food Process Engineering.
Two half day sessions on Food Processing Equipment, Research and Development.
Two half day sessions on Intensive Food Production Systems.
Three half day sessions on Food Product Storage, Packaging and Distribution.

For such an ambitious programme as this the division into sections seemed the only way to ensure that specialists could obtain information on their own subjects. Upon registration a book of digests of the papers was given to everyone, but unfortunately publication of the full papers may take "two to three years". If this is so it will be a great pity as many of the papers would be of great interest and of use to Agricultural Engineers now.

The future of synthetic foods was covered in great depth with emphasis on the nutritional side. Dehydrated and compressed foods as a means of storage together with the protection of stored grains, by such means as refrigerated aeration and dehumidified air for aeration under humid conditions, created great interest.

As would be expected, alternative food sources were discussed at great length, ranging from food and energy from the sea, microalgae, to single cell protein from cellulose, whey protein recovery, leaf protein concentrates and low effluent starch/protein meal production from cull potatoes.

Because of the higher cost of labour in some countries for the hand grading of fruit, several papers were devoted to the mechanical methods being developed as the result of co-operation between industry and various research organisations. This subject was enlarged into the engineering properties of food, covering methods of predicting contact forces on a package of apples and testing the vibration response of solid foods. The use of optical properties of food material in quality evaluation and material saving, the electrical properties of grain and other food materials, infrared-absorption properties of foodstuffs and their significance for technical properties were discussed.

Various papers were given on packaging, international requisites, use of high barrier plastics and the creation of food packaging facilities in developing countries. Having reached this stage the next thing was the comparison of various kinds of warehouse operations and the systems for reducing distribution costs.

In all systems of food processing some form of pollution takes place and management today tries either to reduce this to an acceptable minimum or, by recycling, to eliminate it completely. The American and Canadian Gvernments' approach to effluent regulations were given by members of their respective protection agencies; the higher percentage of papers was given by engineers from commercial plants emphasising the seriousness with which the subject was treated. These papers covered waste water problems in the pickle industry, brine recycling, recovery of vegetable oil refining wastes and a methodology for evaluation of alternatives for new business development from food wastes.

The importance of energy use and conservation was again emphasised by the fact that a paper was given by a member of the US Federal Energy Administration from Washington DC. Whilst most papers were devoted to energy conservation in the poultry processing industry, sugarbeet factories, vegetable canneries and meat packing industry several were devoted to the identification of energy losses and the true energy requirements of the various industries.

The two sections on intensive agriculture contained six papers, one on the practices in Asia, one on hydroponic agriculture, one on the development of a practical solar greenhouse heating system and three on lettuce production by various methods. It was generally felt that this was an area where a greater variety and larger number of projects would have been welcomed.

During the conference a number of round table discussions was held. One was on consumer needs and desires in relation to planning research and development. Others were concerned with scientific and technical communications in food engineering and with forecasting food engineering research and design needs.

A tour was arranged for those interested to visit the US Army NATICK Research and Development Command, Natick, Massachusetts, where work is progressing on all aspects of food technology, freeze drying, compression and dehydration.

Nine papers on food engineering education discussed Bachelors degree programmes and food engineering education generally in the US, Brazil, India and Australia.

The congress banquet was addressed by Dr Magnus Pyke FRSE, Secretary of the British Association for the Advancement of Science who, in his own inimitable way, delighted the very large gathering.

This report was prepared by J F Washbourne TEng(CEI) FIAgrE, managing director, Belvoir Engineering Co Ltd, Belvoir, Grantham, Lincs.

THE INSTITUTION OF AGRICULTURAL ENGINEERS IN ASSOCIATION WITH WREKIN BRANCH SPRING NATIONAL CONFERENCE 29 MARCH 1977, ON THE SUBJECT OF:

CROP PROTECTION:-

THE FACTS – THE FAULTS – THE FUTURE –

REGISTRATION FORMS FOR UK MEMBERS ARE INSERTED.

OVERSEAS MEMBERS WHO WISH TO ATTEND SHOULD WRITE TO **Mrs E Holden,**

The Institution of Agricultural Engineers,
West End Road,
Silsoe, Bedford
MK45 4DU.
Telephone: Silsoe (0525) 61096.

The application of electronics in remote supervision of agricultural and associated systems.

I J Duncan AIAgrE and P Pullen

ALTHOUGH electronics have for many years played an important role in the agricultural industry, generally speaking they have been employed simply as a means of local monitoring and measurement of various functions. We are now reaching the point where, due to the escalating cost of manpower and the large sums of money involved when losses result from automatic process failures, the introduction of remote monitoring and alarm warning systems has become a comparatively inexpensive necessity.

There are many ways in which information may be obtained from a remote site, but most have practical if not financial limitations. The medium of transmission which would appear to offer the most practical, if not indeed the most obvious form of "communication channel", would be the item of electronic equipment most common in the field of domestic contact: the telephone.

Since the Post Office's Public Switched Telephone Network already extends to many million subscribers, and even the most remote agricultural site may be accessible, the basic foundation of a monitoring system can be said to have been laid. There are very strict rules set down by the Post Office within which any piece of apparatus connecting with their lines must conform, but Post Office requirements can be met by equipment which is available and which will provide monitoring and/or alarm warning systems having applications in almost every area of the agricultural industry.

An alarm warning system could be described as a remote piece of equipment terminated at the telephone network and which, when provided with a "start" signal, will proceed to dial a predetermined number in the manner of a conventional telephone. A verbal report, via a pre-recorded tape message will indicate the nature of the alarm. The equipment may go on, if required, to call further telephone numbers and report the same message, or be instructed by the first recipient of the call to reset.

A remote monitoring system on the other hand may be described as a piece of electronic equipment which is terminated at the telephone line on a remote site and which, when called, will report the finite level of a variable quantity. Typically this may be a water level, pressure, temperature, fuel-oil level, flow rate, etc.

Existing local alarm or monitoring systems can often be extended, although some may require an additional interface unit to provide the correct interconnections to the telephone equipment.

Poultry farmers have many applications for remote alarm systems to warn personnel in the event of temperature or ventilation variations and of mains supply failure or fuel shortage. Flow rates of food, drinking water and waste build-up may also need to be monitored. In dairy farming, as each man becomes responsible for more animals, these systems will become applicable where additional equipment may be needed to supervise the milking process. In pig production and calf rearing at present, and in sheep farming in the future, such systems could be invaluable.

In crop drying processes, flow rates, temperature, humidity and fuel levels are important, whether the crop is grain, grass, legume, hops or onions. Animal food production has similar requirements, but is often easier to supervise manually. The successful storage of fruit, potatoes, grain, and salad vegetables depends on accurate control of temperature, humidity and sometimes light. Either alarm systems or monitoring systems can be used to minimise the risk of losses due to breakdown, or human carelessness.

Growers have requirements for monitoring light, humidity, temperature and sometimes CO_2 levels, as well as fuel levels and mains electricity supply. Liquid plant food flow rates and water pressure can also be included. The above applications are for crops under glass, and could apply to mushrooms and rhubarb equally well. Fruit growers may use alarm systems to report temperature levels in scattered orchards, thus allowing them to put into operation timely frost precautions.

Two electronic units which have been developed for use in the United Kingdom are described briefly here.

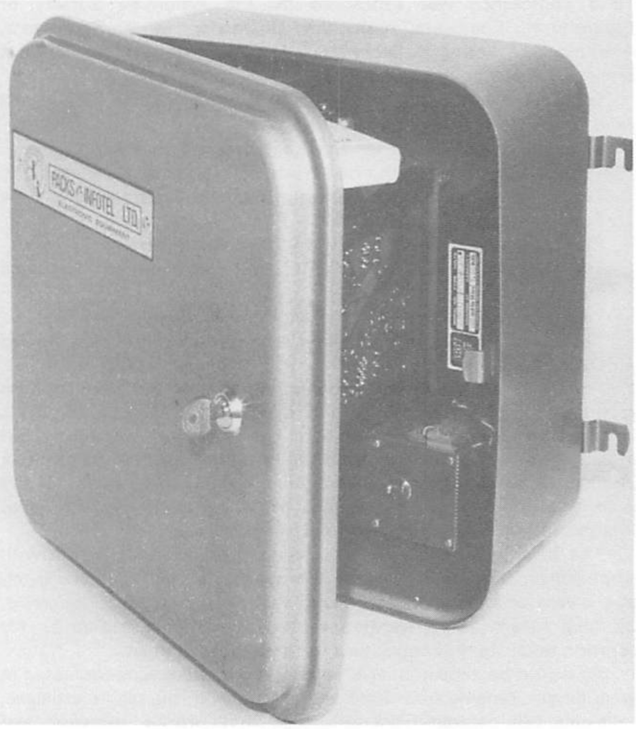


Fig 1

The first, shown in Fig 1, is an automatic dial-out warning device with interrogation and call back facilities. It is capable of telephoning to up to five different telephone numbers and reporting on any of three separate alarm conditions. On interrogation, the unit will report that "all conditions are normal", or if a specific alarm condition exists, this will be reported.

Since the unit only requires an open circuit contact which, on detection of an alarm, closes to activate the circuit, it can be used with a number of water level, mains failure and other alarm condition detectors. Extra facilities can include:-

(a) Mains failure alarm units with suitably delayed operation to avoid unnecessary dial-outs in the event of momentary dips in supply.

(b) Special time circuits to trigger the unit only when an alarm condition has existed for a predetermined period.

The second unit is a single channel date monitoring system which provides for the interrogation of the analogue channel via the normal telephone line. It employs tone answering at the remote station, and the "value" of the remote quantity is displayed in a digital or analogue form on a fixed or portable master station.

Fig 2

Advice on careers in agricultural engineering

TWO prominent aims of the Institution of Agricultural Engineers are "The general advancement of agricultural engineering and mechanisation" and "The promotion of high educational standards in agricultural engineering and mechanisation". Since its inception, the Institution has been very conscious of the need to provide accurate information on careers in agricultural engineering and on the courses leading to them. Institution members took a prominent part in a conference on training and careers in agricultural engineering which was held at Silsoe in April 1965. Subsequently an article, largely written by members of the Institution, appeared in the technical press. There were no formal arrangements for giving careers advice but many cases were dealt with on an ad hoc basis.

When R J Fryett was appointed Secretary and the secretariat had moved to Silsoe, a more formal approach was instituted. A member of the Executive Committee became honorary careers adviser. A leaflet was prepared giving the details of all colleges providing courses which lead to Technician Associate, Member and Fellow grades of membership. The leaflet also referred to other sources of information eg agricultural courses (including mechanisation) and apprenticeship; it incorporated a letter giving general advice and offering an advisory interview. Approximately 400 enquiries per year were received. In addition, about 100 enquiries per year were dealt with on a personal basis. However, there was a sharp rise in the numbers in 1975 when an Institution member gave a short talk on the radio on career opportunities in agricultural engineering. This talk alone generated about 500 enquiries. In addition, the Institution exhibited at BP Landwork 1974 when general information on courses and careers in Agricultural Engineering and Mechanisation was available.

Recently, as part of the normal development in services provided by the Institution, arrangements for careers advice have been modified slightly. A new leaflet has been prepared indicating, in very general terms, the opportunities available in agricultural engineering and advising those interested to write to the Secretary. Providing that the enquiry is straightforward, an up-dated version of the information referred to earlier will be sent. Enquiries requiring special attention will be forwarded to the honorary careers adviser as hitherto. The offer of an advisory interview will be maintained. The purpose of this article is to keep members informed of this branch of Institution activity, not only for general interest, but also so that those who are asked about careers and courses in agricultural engineering and mechanisation can advise the enquirer to contact the Secretary in the full knowledge that very adequate information will be supplied and every assistance given.

Warning of a new farm hazard

FOR many years it has been known that it is dangerous to enter closed unventilated forage or grain silos. Concentrations of carbon dioxide cause involuntary deep breathing and poisonous gases may be inhaled deeply into the lungs, with fatal consequences. The same hazard exists in all slurry containers, and special precautions must be taken before entry.

A recent incident highlights the problem. A worker, who had descended into the region below the slatted floor in a beef house, was affected by the presence of carbon dioxide and hydrogen sulphide. These gases had been produced by mixing the slurry with some silage effluent to help liquification before disposal by tankers. Danger from the gases also extended to 1.5 m above the slats, and so farm animals, as well as farm workers could be affected.

Observation of three main points will help to avoid serious accidents, wherever fermentation of biological matter occurs in a closed space and especially when mixing silage liquor and slurry.

1. Mix slowly and keep people and animals away from the tank or pit.
2. Enter only in emergency, using an airline breathing apparatus and safety harness, or ventilate continuously. (Gas and dust masks do not protect against these asphyxiants.)
3. Install "Gas" warnings and "No Smoking" notices near slurry installations, as well as by silos and conveyor trenchs.

continued from previous page

The power supply for the remote station can be derived from existing equipment, diectly from the mains or from batteries.

To monitor water, sewage, or oil levels, the slave station can be connected directly to a capacitance electrode probe of a special type, or interface units can be employed where there is existing equipment providing a commonly used type of output, eg 0–10mA, 4–20mA, 0–5 volts etc.

We believe that there are at present many possible applications for these and similar electronic devices, not only in agricultural and horticulture, but also in numerous other industries. As new generations of equipment are developed, greater degrees of automation of processes, and more flexible control by management will be possible.

It is not seriously suggested that you should check on conditions at your pig farm, or feed mill, from a conference in Barbados, but you could in fact do so, if you had a note of the correct telephone numbers with you.

The Douglas Bomford Trust

THE objects of the Douglas Bomford Trust are to assist in education, training and research in the science and practice of agricultural engineering.

The Trustees are empowered to make monetary grants for scholarships, bursaries, prizes and similar purposes in pursuance of these objects.

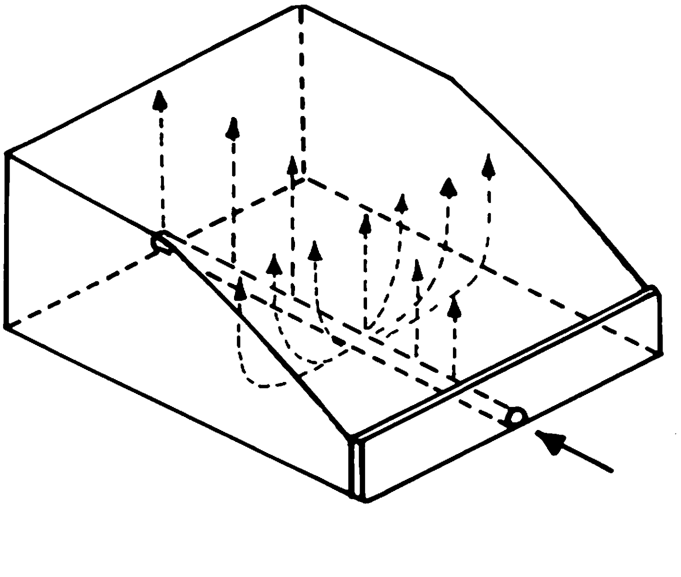
Applications for awards for the 1977/78 academic year are required by 1 May 1977.

Applications for special projects can be submitted at any time.

Information regarding awards, and the method of applying for same, may be obtained from The Honorary Secretary, The Douglas Bomford Trust, c/o The Institution of Agricultural Engineers, West End Road, Silsoe, Bedford MK45 4DU.

IT is regretted that Fig 4 of Dr M E Nellist's paper "Drying of hay and grain" which appeared in the September issue of THE AGRICULTURAL ENGINEER (Vol 31 No 3) was printed upside down. It should have appeared as shown below.

Fig 4. The single lateral duct problem.



AROUND THE BRANCHES

Yorkshire

STIRRING the soil was the title of a paper presented by Mr Michael Williams, UK marketing manager of Howard Rotavator Co Ltd, to the Yorkshire branch at their first meeting of the 1976/77 season at Holmfield House, Wakefield, on 30 September.

A large part of Mr Williams' time was spent on a most interesting review of the history of rotary cultivation. The earliest of the comprehensive set of prints and illustrations he presented on slides was astonishingly dated 1813.

Impartially reviewing the current situation, Mr Williams confessed that while the rotary cultivator is an extremely versatile tool, it can very easily be misused; hence the bad reputation which it has undeservedly earned in certain areas of the world. Brought in at the eleventh hour, for example, in an attempt to create a seed bed in wet clay, the rotavator in inexpert hands frequently results in a bad pan and, above, a porridge consistency which subsequently sets rock hard. With correct setting of the machine, none of this need happen.

Developments continue and Mr Williams described the advantages of the spike rotor and the involvement of the NIAE in developing the high speed rotary digger, which although similar in outward appearance to the rotavator, does a different job and should not be confused with it.

Branch programme 1976–1977

South Eastern Branch

Hon Secretary N Oldacre MIAgrE
Writtle Agricultural College, Chelmsford, Essex (tel Chelmsford 420705).

December 15 Tramlines, by W D Basford (Mechanisation advisory officer, ADAS, Nottingham), Writtle Agricultural College, 19 30 h.

1977

January 19 Analysis of investment in buildings and machinery, by P James (ADAS, Reading), Writtle Agricultural College, 19 30 h.

February 14 Slurry storage and injection, by Dr B F Payne (NIRD, Reading) and D Williamson (Mechanisation advisory officer, ADAS, Maidstone), County Hotel, Chelmsford, 19 45 h.

March 2 Agricultural fork lift trucks. Demonstration during the day followed by an evening meeting on the same subject. Details to follow.

ADMISSIONS

The undermentioned have been admitted to the Institution in the grades stated:-

Fellow (FIAgrE)

Wilken J D	Surrey	13	1	7	76	–

Member (MIAgrE)

Adeniyi T O	Nigeria	–	2	3	76	–
Elliott W J	Aberdeenshire	4	23	5	76	AD
Mustafa A	Berkshire	13	19	7	76	FE
Robinson D E	Essex	12	26	7	76	FE
Woods K P	Eire	–	16	5	76	ED

Companion (CIAgrE)

Mulder A	Sudan	–	9	7	76	–

Technician Associate (AIAgrE)

Bromley-Smith R	Warwicks	8	14	5	76	–
Greig I R H	Surrey	13	24	8	76	PR
Magee G F	N Ireland	–	21	6	76	TS
Minter S G	Peterborough	2	21	6	76	FE
Ojo P O	Nigeria	–	3	5	76	ED
Turner I T	Worcs	8	21	6	76	TS

General Associate (AIAgrE)

Bagshaw D E	Kent	–	16	7	76	AD
Emms J R	Norwich	1	24	8	76	FM
Gadbury P J	Suffolk	1	15	2	76	AD
Henderson C	N Ireland	–	21	6	76	DM/RD
Hunter W R	N Ireland	–	21	6	76	TS/DM
Legg D J	Somerset	6	24	8	76	AD
Mountain W C	Sussex	13	22	6	76	BD/ED/FM
Nielsen V C	Berks	13	13	4	76	AD
Payne D	Avon	7	29	7	76	–
Ralph D L	Warwicks	8	27	4	76	TS
Royle J F	Kenya	–	22	6	76	CS
Secker C L	Lincs	2	21	6	76	DM

Graduate

Barr H W	Eire	–	21	6	76	ED
Bragg N C	Middx	13	24	8	76	AD
Dineen T J	Eire	–	2	6	76	TS
Eden C M	Oxon	13	16	7	76	AD/TS
Hird J R	Lancs	11	13	7	76	DM
Inman M W	Yorks	10	26	7	76	ED
Powell C R	Sussex	13	16	7	76	TS
Powell D F	Worcs	8	24	8	76	TS
Shiles N J	Lincs	2	17	7	76	FM
Tinker D B	Norfolk	1	15	7	76	DM/RD
Wynne D A T	Cornwall	6	17	7	76	FE

Student

Meek C	Cumbria	3	13	7	76	FM
Murphy S P C	Lincs	2	1	7	76	–
Park P G	Cheshire	11	12	3	75	–
Reid M G H	Herts	5	13	7	76	–
Rennie K A	Beds	5	5	7	76	–

TRANSFERS

The undermentioned members have been transferred to the grades stated:-

Fellow (FIAgrE)

McRae D C	Midlothian	4	8	7	76	RD
Tullberg J N	Beds	5	8	7	76	ED

Member (MIAgrE)

Adesuyi S A	Nigeria	–	5	1	76	RD
Brunner S G	Greece	–	29	11	75	TS
Collis J M	Glos	7	26	7	76	AD/FM
Kunihira P D	Kenya	–	24	8	76	TS
LePatourel C E	Rhodesia	–	10	5	76	FM
Osborne G	Essex	12	9	6	76	–
Robertson S W	Gwent	7	26	2	76	ED
Robertson T W	Aberdeenshire	4	10	5	76	AD
Stansfield C B	Lincs	2	19	7	76	AD/FE
Talabi A E O	Nigeria	–	5	1	76	RD
Tring I M	Lincs	2	16	5	76	–
Watson P D	Tanzania	–	10	6	76	TS/FM
White I S	Staffs	9	19	7	76	CS
White W	Eire	–	19	7	76	TS
Wicks A E	Kent	–	3	6	76	FE/FM
Wilson R G	Surrey	13	26	7	76	AD/FE
Yardley R W	Lincs	2	16	7	76	ED

Companion (CIAgrE)

Taher El Issati A M	Spain	–	8	4	76	FE

Technician Associate (AIAgrE)

Loades B C W	Rhodesia	–	25	3	76	DM/RD
Oyekanmi T A	Nigeria	–	23	9	75	TS/ED
Walton J M	Yorks	10	9	6	76	TS
Williams D B	Yorks	10	3	5	76	DM

General Associate (AIAgrE)

Reynolds J E V	Lancs	11	16	7	76	AD

Graduate

Embrey R M	Staffs	9	21	6	76	CS
Jeevunjee S H	Oxon	13	3	2	76	–

RE- INSTATEMENTS

The undermentioned has been re-instated:-

Member (MIAgrE)

Kunihira P D	Kenya	–	9	8	75	TS

RESIGNATIONS

The undermentioned have resigned from membership of the Institution:-

Cowell J	Beds	5	29	6 76	Economic
Frizelle D A	Gwent	7	14	7 76	Economic
Heuer F J	S Africa	–	3	8 76	Retirement
Laws S H	Surrey	13	2	8 76	Economic
Rowe T J	Herts	5	30	9 76	Retirement
Scott R G	Warwicks	8	18	7 76	Retirement from agriculture
Stroud D A	Oxon	13	7	9 76	Economic
Tesoriere P I	Rutland	2	14	6 76	Economic
Vowles J	Bucks	5	23	4 76	Leaving the country
Whyte D	Notts	2	6	8 76	Economic

DEATH

We regret to announce the death of the undermentioned member:-

Collingwood K	Yorks	10	31	5 76

ENGINEERS REGISTRATION BOARD

The undermentioned have been placed on the ERB(CEI) Register:-

Technician Engineer (TEng [CEI])

Doughty W R	Berks	13	13	8 76
Gander J A J	Sussex	13	15	7 76
George J A	S Africa	–	13	8 76
Green B	Ayrshire	4	13	8 76
Hale O D	Beds	5	15	7 76
Harris P W	Dyfed	–	13	8 76
Heygate C N StC	Devon	6	15	7 76
Huzzey M D	New Guinea	–	10	8 76
MacCormack J A D	Aberdeenshire	4	23	9 76
Mahdi I K	Sudan	–	15	7 76
Mason G G	Worcs	8	13	8 76
Mitchell D G	Warwicks	8	13	8 76
Peacocke N F	Rhodesia	–	13	8 76
Rushton D H	Yorks	10	15	7 76
Sarker R I	Beds	5	13	8 76
Sheldon M C	Surrey	13	15	7 76
Stamp J T	Devon	6	13	8 76
Storey S	Aberdeenshire	4	15	7 76
Thiagarajah V	Malaysia	–	13	8 76
Tomlins C M	Malta	–	15	7 76
Trevarthen R H	Leics	2	15	7 76
Waggit P W	Berks	13	23	9 76
Whetnall C R	Fiji	–	13	8 76
Wilcher A D	Sudan	–	13	8 76
Yap Boon Chark	Singapore	–	13	8 76

Technician (Tech) [CEI])

Brooks C F	Herefords	8	15	7 76
Mitchell I D	Yorks	10	13	8 76
Pearson S P	Senegal	–	15	7 76
Pereira P R	Malaysia	–	13	8 76
Rigby J S	Worcs	8	13	8 76
Roach S H	Salop	9	1	3 76
Watson A W	Cumbria	3	15	7 76

Occupational classification
AD – Advisory Services; BD – Buildings; CS – Consultancy; FE – Field Engineering; PR – Technical Journalism; TS – Technical Sales, Distribution and Service; DM – Design and Manufacture; ED – Education; EL – Electrification; FM – Farming; RD – Research and Development.

Branches
1 East Anglia; 2 East Midlands; 3 Northern; 4 Scotland; 5 South East Midlands; 6 South Western; 7 Western; 8 West Midlands; 9 Wrekin; 10 Yorkshire; 11 North Western; 12 South Eastern; 13 Southern.

THE INSTITUTION OF AGRICULTURAL ENGINEERS ANNUAL 1977 CONFERENCE WILL BE HELD ON TUESDAY, 10 MAY 1977 AT THE BLOOMSBURY CENTRE HOTEL, CORAM STREET, RUSSELL SQUARE, LONDON, ON THE SUBJECT OF:

THE AGRICULTURAL ENGINEER AND WORLD PROTEIN PRODUCTION PROBLEMS

Anyone requiring further information should write to:

Mrs E Holden,
The Institution of Agricultural Engineers,
West End Road,
Silsoe, Bedford
MK45 4DU.

Telephone: Silsoe (0525) 61096

Secretary's notes

Annual subscription notices 1977

SUBSCRIPTION notices for 1977 were posted to all members of the Institution during the period 15/16 October 1976.

If any member has not received his notice by the time he receives this Journal he is requested to advise the Institution Secretary promptly.

All IAgrE and ERB subscriptions for 1977 are due on 1 January 1977.

For those members who use the Bankers Order method of payment, it is hoped that they noted the special instructions enclosed with the renewal notice.

Council have issued instructions that the Journal cannot be mailed until subscriptions have been paid.

Membership lists

MEMBERSHIP lists covering UK branches or counties, and individual countries abroad, were distributed to all members of the Institution in June 1976.

It is proposed that amended lists will be distributed in the same manner in June 1977.

If any member is travelling out of his area to any other specific district, the Institution Secretary will be pleased to provide a list of members upon application; 14 days notice would be appreciated.

Certificates of membership (IAgrE)

CERTIFICATES of membership of the Institution are available on application to the Institution Secretary.

IAgrE updating cards

IAGRE updating cards were again sent out with the subscription renewal notice to all members. It would be of considerable help to the Secretariat if members would make use of these cards, as the occasion arises, and send them promptly to the Institution Secretary,

These cards should not be confused with the ERB updating cards, which are used for entirely separate administrative processing.

New appointments

THE Honorary Editor will be pleased to make every effort to publish any information concerning changes of occupation of members in senior appointments.

Details should be addressed to the Institution Secretary. Marked "Appointment Change".

Journal mailing

THE attention of all members is drawn to the fact that addressed envelopes are prepared for Journal mailing approximately four weeks before posting on the fifth day of March, June, September and December.

It is regretted that changes of address received after the envelopes have been prepared cannot be incorporated until the following quarter.

Council have issued instructions that the Journal is not to be mailed until subscriptions have been paid.

County boundaries – England and Wales

ALL members who are resident in an area which has been involved in the change of county names, are reminded that unless they notify the Institution Secretary of their postal code, neither the Institution nor the postal authorities can accept any responsibility for mail not reaching its destination.

Secretariat end-of-year audit and holidays

THE Secretariat will be closed for all day-to-day business from cease work on Friday 17 December 1976 until the morning of Tuesday 4 January 1977.

This period is intended to cover statutory holidays and audit work.

Membership admissions and transfers

NEW regulations come into effect on 1 January 1977 concerning the qualifications required of applicants to any grades of membership of the Institution.

The new Guide to Membership is with the printers and will be published as soon as possible; in the meantime any member or prospective member requiring further information should contact the Institution Secretary.

ENGINEERS REGISTRATION BOARD

Certificates of registration

CERTIFICATES of registration for Technician Engineer (CEI) and Technician (CEI) are available at the cost of £3 (including postage and packing) which is payable with order.

Application forms can be obtained from the Institution Secretary.

Due to increases in postage costs it is anticipated that there will be an increase in the cost of these certificates in 1977.

Updating cards

MEMBERS who are registered with the Engineers Registration Board are especially requested to complete the updating card (printed black) as the occasion arises, and send it to the Institution Secretary for annotation and passing on to the Board.

These cards are not to be confused with the IAgrE updating cards which are used for entirely separate administrative processing.

The Autumn Conference of the Institution was held at a later date than usual this year. It will be fully reported in the next issue of The Agricultural Engineer.

Dunlop Scholars

THE Dunlop Scholar for 1975/76 was Geoffrey R Rudd, a Geography graduate of the University of Durham, who has used the award to enable him to follow an MSc course at the National College of Agricultural Engineering, (NCAE), Silsoe.

After graduating at Durham, Mr Rudd spent three years in Zambia as a Land Use and Conservation Officer. During this time he realised that, for farm planning work he needed an increased agricultural background and a relevant qualification. Accordingly, in 1974/75 he entered the NCAE to read for a postgraduate diploma in soil and water engineering, part of which involved a special study of the socio economics of tribal structure related to irrigation design in Zambia.

Following his interests in irrigation still further, Mr Rudd gained entry to the MSc (Soil and Water) course at NCAE in October 1975. His MSc research has been on the subject of "Soil Moisture Management Related to the Growth and Yield of Potatoes".

The wisdom of his decision to acquire a recognised qualification in his chosen branch of agricultural engineering is reflected in his recent success in obtaining an appointment as an irrigation agronomist with the Dunlop Irrigation Services Division at Thame, Oxfordshire. He will be working largely in a consultative capacity, spending a good deal of his time on the application of irrigation in overseas situations. We wish him well in his future employment.

●

THE award is announced of the College Diploma in Agricultural Engineering to James Nevin, recipient of a special supplementary Dunlop scholarship for 1975/76. Mr Nevin has completed a year's course at the West of Scotland Agricultural College having previously studied for the City and Guilds Agricultural Engineering Technicians 030 Award at the Ballyhaise Agricultural College, Cavan, Eire. At the present time Mr Nevin is working in his brother's agricultural contracting business in Eire.

Geoffrey Rudd

James Nevin