agricultural engineer

Volume 50 No. 4 Winter 1995

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Dirty water or dilute waste?

By JP Frost

At Hillsborough, dirty water run-off from concrete farmyards and open silos has been shown to contain significant concentrations of nitrogen, phosphorus and, in particular, potassium. Sprinkler irrigation of this dirty water on to grassland has resulted in a significant increase in soil potassium concentration. It is suggested that "dilute waste" much better describes the material being irrigated than "dirty water".

Introduction

The Agricultural Research Institute of Northern Ireland is one of the UK's foremost research stations carrying out research work on animals and crops. Located 12 miles south west of Belfast the 250 hectares of land are predominately perennial ryegrass. The soils are boulder-clay derived from glacial deposits and have an average texture class of clay loam to sandy clay loam. Each year the Institute ensiles 10,000 t of grass, finishes 300 beef cattle and milks 250 dairy cows.

Up to 1989, 18,000 m^3 of slurry (including parlour washings, silage effluent and soiled water from concrete yards)were land spread by tractor and tanker at the Institute. In 1988, concerns over inefficient and costly slurry spreading led to a review of slurry storage, handling and distribution that resulted in setting up a system to collect an estimated annual 7,000 m^3 of silage effluent and dirty water. This material was to be sprinkler irrigated on to 10 hectares of free draining grassland with no installed drains and used for grazing dairy cows. In keeping with the best information available at the time, and in line with the subsequent Code of Good Agricultural Practice for the Protection of Water (MAFF, 1991), irrigation was to be limited to a maximum of 50 m^3/ha per application at 21 day intervals and at an application rate of less than 5 mm/h. The system, which has previously been described by Frost and Brewer (1990), consisted of a PVC underground main with hydrants leading to quick coupling galvanised above ground laterals laid semi-permanently along the fence lines of paddocks. The laterals were fitted with quick connect riser pipe couplings at 36 m centres into which the sprinklers could be fitted. The sprinklers were moved daily to a new lateral so that the requirements for application interval were met.

The Agricultural Reaearch Institute for Northern Ireland
Large Park
Hillsborough
Co Down
Northern Ireland
BT26 6DR

Volumes collected

Since commissioning of the system in the autumn of 1989, approximately 28,000 m^3 of liquid have been collected of which about 52 % have been irrigated (*Table 1*).

The periods in the above table represent the main silage effluent producing months of May to September inclusive and the winter/spring months of October to April inclusive. Measurements of volumes indicated milking parlour wash-

Table 1 Volumes of dirty water collected and irrigated at Hillsborough between November 1989 and September 1994.

Date (inclusive)	*Collected m^3*	*Irrigated m^3*	*Transferred to slurry m^3*	*Rainfall, mm*	*Rainfall % of average*
Oct'89-Apr'90	3310	3310	0	479	90
May'90-Sep'90	2599	1276	1323	300	56
Oct'90-Apr'91	3868	1373	2495	653	122
May'91-Sep'91	2419	155	2264	181	34
Oct'91-Apr'92	606	606	0	557	104
May'92-Sep'92	2913	29	2869	379	71
Oct'92-Apr'93	4390	3727	923	492	92
May'93-Sep'93	2625	36	2322	396	74
Oct'93-Apr'94	5181	3999	1182	454	85
May'94-Apr'94	2976	943	2033	278	52
Total Oct'89-Apr'94	27911	14511	13378		
Av May-Sep (5 years)	2706	488	2162	320	100
Av Oct-Apr (4 years)	4187	3102	1150	535	100

ings to be 9.1 m³/day (3322 m³/year). It is estimated that silage effluent production from grass ensiled unwilted could amount to 1200 m³/year. Apart from the period October 1991 to April 1992, the volumes collected have increased each year and this is despite all grass cut for silage since 1993 being wilted for 24 hours in order to reduce or eliminate effluent production. The annual increase results from a greater awareness of dirty water at the Institute that has lead to an increasing area with run-off being collected. The period October 1991 to April 1992 was exceptional in that the collection tank was out of commission and had to be replaced (see later). During this period it was not possible to monitor collection of dirty water. The average rainfall at Hillsborough over the period 1986 to 1994 was 827 mm/annum with 34% occurring over May to September inclusive and 66% occurring over October to April inclusive. It is estimated that the sprinkler irrigation system has resulted in a saving of more than 400 slurry tanker round-trips each year. Because of careful site selection for irrigation, there has been no evidence of surface run-off of irrigated liquid.

Grass scorch

During the first summer of irrigation in 1990, grass scorch was a major problem in the irrigated areas (*Figure 1*). This scorch was presumed to have arisen from the high concentration of silage effluent in the irrigated liquid together with the repeated high rates of application. Other work at the Institute has indicated that grass will scorch when silage effluent is applied at more than 50 m³/ha to grass regrowths after 15 days from taking a silage cut (Binnie and Frost, 1995). As a consequence, very little irrigation has been carried out between May and October in each year since 1990, with all liquid collected being transferred to slurry stores for land distribution by tanker on other areas. This transfer resulted in sufficient dilution of the effluent to prevent scorch.

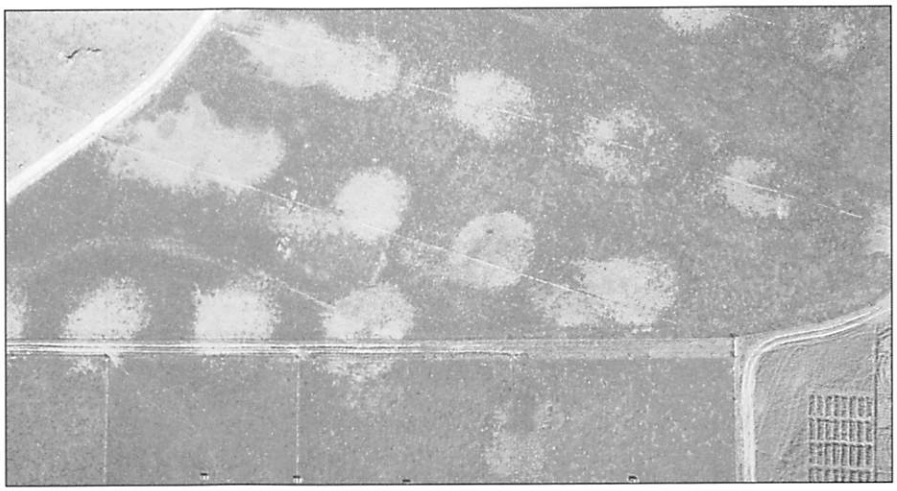

Fig. 1 Aerial view of paddocks at Hillsborough that are sprinkler irrigated, showing grass scorch caused by silage effluent.

Soil chemical composition

While the effects of low rate irrigation of dirty water on drainage water quality have been studied (Williams and Nicholson, 1995), little information is available on its effects on soil chemical composition. Since irrigation commenced in the autumn of 1989, soil in the irrigated and not-irrigated areas haî been sampled annually in spring and analysed for pH and concentrations of potassium, phosphorus and magnesium (*Table 2*).

Table 2 Soil chemical composition from grassland at Hillsborough with and without sprinkler irrigation of dirty water.

Year	Soil nutrient concentrations, mg/l						Soil pH	
	P not irrigated	P irrigated	K not irrigated	K irrigated	Mg not irrigated	Mg irrigated	Not irrigated	Irrigated
1988	76		279		148			
1989	72		249		169			
1990	NR	71	NR	347	NR	182	NR	5.2
1991	75	83	232	440	151	159	5.8	5.9
1992	65	73	211	349	157	141	6.2	6.1
1993	66	73	255	340	195	189	6.5	6.5
1994	50	64	253	405	178	172	6.5	6.5
1995	45	53	321	439	185	181	6.5	6.6

Dirty water chemical composition

Samples of dirty water were taken at weekly intervals from the main collection tank throughout a complete year and were analysed for N, P, K, and pH (*Figure 2*). Throughout the year the pH of the material remained between 4 and 5, with an average value of 4.6. It is clear from Figure 2 that the dilute waste collected had a significant and variable plant nutrient content. In particular the potassium concentration was high during the main silage effluent production months May to September (peak of 2,400 mg/l in July 1994). It is also worthy of note that there were significant concentrations of N, P and K in dilute waste coming off farmyards during winter when silage effluent production was at a minimum. . It is estimated that over the period 1989 to 1994 the quantities of N, P and K collected in the tank were respectively 15.4 t, 2.7 t and 25.7 t. Had all this liquid been irrigated over the entire 10 ha available it would have given an equivalent annual application of 308 kg/ha of N, 54 kg/ha of P and 514 kg/ha of K. Increased concentrations of P and K in the soil as a result of sprinkler irrigation of dirty water are therefore explained.

Sprinkler application rates

Within the wetted area from each sprinkler, it was found that there was variation in application rate, with the heaviest applications being at the centre. The sprinklers have a specified wetted radius of 18.4 m with an output of 3.4 m³/h at a pressure of 3.4 bar. In practice, it was found that the wetted radius was only 15 m at this throughput and pressure. As a

result, application rate per unit time per unit area is about 50% more than that quoted by the manufacturer. Soil samples were taken at different distances radially from the centre of each sprinkler point so that each sample represented a semi circular area of approximately 100 m^2. In addition, a soil sample was taken from a non-irrigated area in the centre of the paddock at each sprinkler point. *Table 3* indicates the effect of the uneven application rate from sprinklers on soil chemical composition. In summary, the areas that were sprinkler irrigated had a much greater application rate and a more uneven supply of nutrients than had been anticipated. In particular, the areas closest to the sprinkler were very overloaded with nutrients.

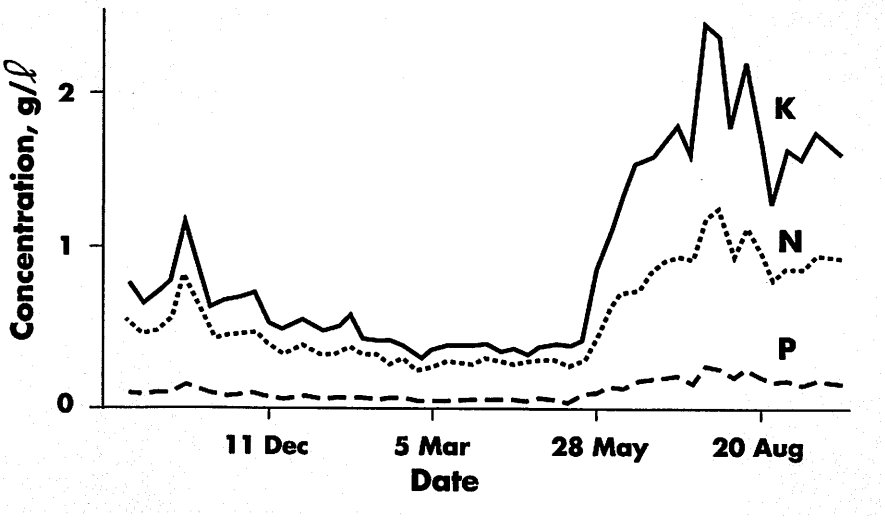

Fig. 2 Weekly chemical composition of dilute waste collected at Hillsborough between September 1993 and October 1994.

Operational problems

In the autumn of 1992, the vitreous coated steel tank (15 years old and previously used for storing slurry) was found to have a number of leaking panels caused through corrosion by the tank contents. This tank was replaced with an industrial grade vitreous coated steel tank.

In 1995, the galvanised above ground laterals were found to be corroded on the inside to such an extent that they were unserviceable. When the system was originally specified the small mobile irrigators then available used lay-flat hose that required gathering and moving each time the irrigator was to be moved. It was considered that the system installed of semi-permanent above ground laterals with moveable sprinkler heads would be easier to manage and involve less labour. However, since the original installation, small hose reel sprinkler irrigators became available. It was cheaper to purchase a small hose reel type sprinkler irrigator than replace the existing system of galvanised laterals. While the time taken to move and reset the sprinkler system each day has increased as a result of this change, the greater flexibility of being able to sprinkler irrigate areas outside the original 10 hectares has already been an advantage. In addition, the hose reel irrigator has a greater wetted radius (24 m) and a more even application rate than the original fixed point sprinklers. Consequently, the more even and wider spread of the liquid should help to keep the build up of soil nutrient concentrations in check. In addition, no phosphate or potassium fertiliser is applied to the sprinkler irrigated areas.

Table 3 Average chemical composition of soil within irrigated areas at Hillsborough (distances are approximately 100 m^2 increments from sprinkler).

Distance from centre of sprinkler, m	*Average soil status 1995, mg/ℓ*			
	pH	*P*	*K*	*Mg*
1	6.50	64.5	577.1	160.9
8	6.54	64.8	555.2	172.9
11.5	6.61	56.1	493.1	180.1
14	6.61	49.4	419.9	181.2
16	6.57	49.1	378.7	186.5
18	6.52	47.0	344.3	183.9
Non irrigated (centre of paddock)	6.53	44.6	320.8	185.1
Sem Significance	0.024 **	1.5 ***	16.9 ***	5.8 *

Subjective observations during irrigation indicate that the dirty water has an unpleasant smell. Care is taken to avoid irrigation when the prevailing wind would cause odour drift to nearby domestic dwellings.

Conclusions

Dirty water from farm yards and silos contains significant concentrations of plant nutrients and would be more accurately termed as dilute-waste. In order to prevent excess accumulations of P and K in the soil of irrigated areas it is important to sprinkle irrigate uniformly over as wide an area as possible and to have the soil regularly analysed. Because silage effluent has a high K concentration, it is suggested that effluent is either irrigated over as wide an area as possible or is removed from the irrigation system altogether.

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Binnie R C, Frost J P (1995). Some effects of applying undiluted silage effluent to grassland. *Grass and Forage Science* (in press).

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Productivity stable in the agri-machinery industry

A study of the UK agri-machinery industry for the Autumn edition of the Plimsoll Portfolio Analysis has revealed that productivity runs well above that for UK industry generally. On average, the industry achieved £158,000 sales per employee and 37% of the industry achieved this level of productivity or better. The largest companies, those whose turnovers exceeded £21 M, averaged 3178,000 sales per employee, while the smallest companies, those with turnovers below £4 M, could only achieve £122,000 sales per employee, a level matching the average productivity for UK industry as a whole.

While on average sales had increased by 17%, the report again highlighted a considerable variation in performance. The largest companies reported an average 15% growth in sales, whereas the smaller companies averaged 12% growth. The highest level of growth was found in companies ranging in size between £4 M and £9 M, these companies managing to achieve some 27% sales growth.

The gains in sales helped fuel the increases obtained in profit margins for the industry. The industry as a whole reported an average 2% pre-tax profit margin, again improving on the situation a year ago when pre-tax profit margins were 1% of sales. The largest companies fared better, returning profit margins of 3% compared to 2% as reported by the smallest companies.

The report, the Plimsoll Portfolio Analysis, Agri-machinery - Autumn Edition 1995, details some 1582 companies involved in the industry. The report focuses on individual performance and its graphical interpretation of the companies accounts makes it quick and easy to use. This enables the busy manager to quickly identify the strong companies, those that have capitalised on the improvements in the economy since the recession, from the weaker companies which have not been able to respond as quickly. With this information, the busy manager is able to choose the best companies with which to trade.

For more information on the report which costs £295, contact: Mark Haynes, Plimsoll Publishing Ltd, tel. 01642 230977.

Fluid power training centre

Agricultural personnel who install and service mobile plant hydraulics and pneumatics can benefit from a training arrangement between world leaders in hydraulics and pneumatics Robert Bosch Ltd and the North Notts Fluid Power Centre, a satellite of the North Nottinghamshire College.

The partnership sees Bosch supplying technical support, ongoing training and more than £80,000 worth of the latest Bosch hydraulic and pneumatic technology to the Centre's learning programmes. A fully equipped Bosch electro-hydraulic training room has recently become operational at the centre.

From January 1996, the Centre will offer courses for industry and Bosch customers in pneumatics, electro-pneumatics, hydraulics and electro-hydraulics. These will include City and Guilds 2340 Fluid Power certificate courses with open flexible learning, and specific courses meeting the requirements of individual manufacturers. This training initiative will help British industry boost productivity and reduce downtime, allowing maintenance and design staff to better manage their fluid power systems. Course enquiries to: John Savage, North Notts Fluid Power Manager, tel. 01909 732196.

Educating for the environment

By responding to the Scottish Environmental Education Council (SEEC) questionnaire, the IAgrE has been identified as one of the many professional bodies who are either involved in or are developing initiatives in environmental education and training. The SEEC is running a Professional Development Symposium for policy makers on "Sustainability and the Urban Environment" in January, 1996. The symposium aims to give participants the opportunity to develop a methodology and framework for sustainability, and to produce agreed recommendations and principles for sustainable urban development. Topics covered will include transport, energy and resources, waste, community, built environment, natural environment and economy. The symposium is expected to provide an opportunity:

- to explore the strategic, organisational and personal issues that arise from the need for sustainable urban development;
- to identify opportunities, threats, trends and the potential for development of new products and services;
- to experience inter-disciplinary consensus building and decision making with key policy makers from other sectors;
- to assess the impact of resource allocation and decision making on environmental quality and social equity;
- to link continuing professional development with increased understanding of environmental issues.

One of the outcomes of the symposium will be the production of a training package on sustainable development based around the theme of the urban environment. It is SEEC's intention to distribute this package to as many professional bodies as possible. As a result, the package will be designed so that it can be readily incorporated into existing training activities.
IAgrE has expressed interest in receiving the training package when it becomes available in early March. For more information, contact Michael Hurst, IAgrE Secretary, tel: 01525 861096

Dealing with a pollution incident in forestry

David C Jardine, Steve Penny and Tom Bowbeer

In this paper, we describe one of those occasions when a comment made in the morning comes back to haunt you in the afternoon. On 16 September 1992, David Jardine took a group of 15 harvesting foresters on a mechanised harvesting course round a series of production sites in Kielder Forest. In the morning, he explained that the district was fully geared up for dealing with oil spillages; following lunch, he rounded a corner in Bewshaugh and found an articulated lorry lying on its side with the last remnants of diesel leaving its fuel tank. His confident assurances were now to be tested.

The remainder of this paper describes the actions which were taken on this particular incident and provides guidelines to others on how they can increase their preparedness for such an occurrence. Failure to respond appropriately could result in prosecution by the River Purification Board or (in England and Wales) the National Rivers Authority.

Immediate responses

The first lesson learnt from this incident was the need to have all the operators involved at the sharp end aware of the action which should be taken if they are involved in an incident. It is fine to have the best laid plans but, if the operators are not fully involved, they will go astray. The wagon had been on its side for over an hour and the driver, who was unhurt, had sought help from an adjacent forwarder in unloading the wagon. They had not realised the fuel was running into the water course and, therefore, the first rule of dealing with a pollution incident had been broken:

• *contain as much of the pollution at source as is possible.*

This can be achieved by many means. Not all forest vehicles carry all the equipment required to deal with a substantial spillage and it is probably reasonable that they do not, but containment can be achieved using natural materials and improvised tools:

logs and turves can be used to block drains where the spillage has occurred;

spades, kept in vans for winter use, or forwarder grapples if available can be used to move earth and other materials.

When David Jardine radioed Tom Bowbeer to explain the situation, they knew that there was an uphill battle ahead because the roadside drain led to the Capon Burn which quickly led to the Kielder reservoir. Fortunately, Tom was available and dealt with the problem, while David continued with the last stop on the training course before returning to assist with the clear-up. A second lesson was learnt:

• *good communications are a big help.*

Tom had two problems to deal with immediately:

to identify the extent of the diesel pollution, and

to prevent further expansion.

The latter was particularly difficult at the time. While he had available proprietary equipment, such as pads, pillows and booms which had been used for tidying up static spillages, he had not dealt with one involving flowing water. Most of the spillage was still in around half a kilometre of roadside drain which was quickly blocked by a back-acter available from the road squad. This was only a temporary solution as the volume of flow would mean that it would soon be swamped.

A series of dams were constructed using timber boards and stakes, or sand bags to create areas of static water where the proprietary products could be used (*Figure 1*). Initially, flow was regulated using gaps between boards but later, when available, plastic piping was used to create underwater sluices which allowed

Fig.1 Absorbent pads in place behind a temporary dam.

water flow down the drain without letting any diesel escape. Rainfall during the coming week meant that these dams had to be monitored regularly because the clean up operation remained in place to purge the drain of diesel.

With the help of Northumbrian Water, a floating boom was stretched across the area of slack water where the Capon Burn entered the reservoir as an additional precaution (*Figure 2*). Once containment actions had been taken, the National Rivers Authority were contacted and their pollution control officer soon visited the site. He expressed agreement with the action which had been taken.

All the used pads, pillows and booms were collected during the incident and stored in polythene bags prior to their disposal through a waste disposal company.

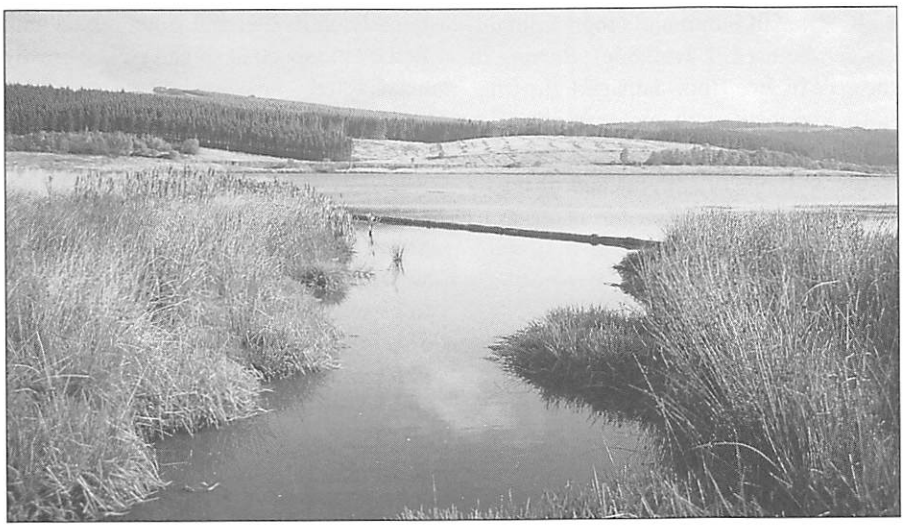

Fig.2 A miniboom across the mouth of the burn at the reservoir

In the debriefing that followed the incident, a number of significant points came out:

- the need for quick action similar to a forest fire;
- the need for a Pollution Plan similar to a Fire Plan;
- the need for appropriate equipment to be immediately available.

The pollution plan

A number of Forest Districts have now developed a Pollution Incident Plan. They usually consist of two parts, Action Plans and Information Sources.

Action Plans
What to do in the event of a spillage
Safety
Stopping further spillage
Summoning assistance
Informing others
Dealing with a spill
Office procedures in the event of an incident
Incident reporting

Information Sources
Equipment holdings
Contact numbers for
- private water supplies
- interested neighbours
- waste disposal
- machinery hire

National Rivers Authority/River Purification Board interests
It is likely that many forest users and owners will propose similar contents for the first section, but each individual location will have a unique set of information sources. Extracts from the Borders Forest District Pollution Incident Plan are included in Appendix 1.

Equipment holding

A wide variety of equipment is suitable for dealing with pollution incidents. The distribution and storage of these will be a function of the personnel and geography in any forest. In some areas, it will be appropriate for all vehicles to carry a fairly large "first aid kit" and have a relatively small central supply. This approach would be sensible for an area with widespread forests and groups of remote workers. In a more compact forest with good communications, a smaller "first aid kit" with a central incident trailer may be more appropriate. The following are the main items which should be held and their use.

Safety equipment
Chemical gloves and sleevelets
- essential items of safety clothing

Absorbent towel rolls
- for clearing equipment

Large polythene bags
-for safe disposal of waste

Tools
Mattocks
Garden spades
Round mouth spades
Fencing maul
Pinch bar
Claw hammer
100 mm nails
Bow saw
Stanley knife - for polythene and rope

Dam building equipment
Sandbags - filled
Sandbags - empty
Short stakes - for securing booms and cushions
Large stakes - 1.5 m x 75 mm x 74 mm
Wooden boards - varying sizes
Polyprop rope
Heavy duty polythene sheeting
Plastic piping
- 100 mm diameter has worked well
- various lengths helpful
- include slight (22.5°) joints

Oil absorbent equipment
Straw bales - a cheap and moderately effective method in certain circumstances for first filtration of polluted watercourse; not as effective as the following proprietary products (see Appendix 2 for suppliers).
Oil absorbent pads - good for small spills and can be laid on the surface of polluted water to skim it clean.
Oil absorbent cushions - ideal for blocking culverts and for removing large quantities of oil from contained sites but should be attached with rope or string for removal as the cushion will sink when full of oil.
Mini-booms - a sausage of cushions with rope attachment - again anchored to prevent loss through sinking - ideal for skimming oil from top of slow moving flat water.
Booms - larger version essential in a major incident involving a large water course, and several mini-booms can be joined to provide a temporary substitute early in an incident.

Additional items - particularly helpful in certain circumstances
Oil drums/tanks/bowsers - for the removal of polluted water, waste oil etc.
Drum funnels - anti-splash funnels for filling drums.
Sludge pumps - to empty areas where pollutants have been contained on site, a wide aperture pump handling contaminated waste with grit, needles, twigs, etc, being better than an old fire pump.
Drain seals - a proprietary clay sheet for placing over road drains to contain spillage.
'Dammit' - a clay based proprietary product which, when mixed with water, seals leaking pipes, drums or bowsers for up to 24 hours.
Mobile bund - for placing on ground to contain spillage from leaking bowsers and tanks towed or lifted onto it, after which sides of bund raised.
Water bottles - for collecting samples for analysis.

Conclusions

From our iterative experiences in dealing with pollution incidents and in preparing Pollution Plans, we now feel that the advice which we have given will provide a sound basis for others dealing with most oil pollution incidents. There are incidents which are outwith our experience and there is one particular forest problem for which we cannot yet propose an answer. Urea, being a water based substance, will mix with water in the forest and at present our only suggestion is to dilute any spillage as much as possible to lesson any harmful effect.

To summarise, the message we would give to others about oil pollution - *CATCH IT*
Contain the spillage: time is of the essence.
Alert others as soon as possible.
Clean up using appropriate materials.
Seek help and advice from other sources eg Fire Service.
Prepare an incident report.
Tidy up, dispose of materials safely.

Acknowledgements

We are grateful to our Forest District Managers, Bob McIntosh and Peter Weston who guided and encouraged us to work towards practical solutions for these incidents.

Further reading

Forestry Commission (1993). Forests & Water Guidelines. HMSO London. 32pp.

Appendix 1 - Action in the event of a spillage

1. Assessing the problem, enlisting assistance, informing others

Safety
Consider the safety of yourselves and others. Is it safe to enter the spill area, is protective clothing required, is there a danger of fire or explosion?

Stop further spillage
This is a fairly obvious move but not always easy to achieve. Fuel leaking from the ruptured fuel tank of an overturned vehicle is not always easy to collect or stop. A small pump and empty containers can be used if available. Beware of the risk of fire from damaged electrics, hot components and fuel and oil. Use whatever natural materials are available to block drains or streams and, if possible, place a boom or cushions on accumulations of oil to prevent it flowing downstream.

Summon assistance
Calls for assistance should also include requests for machinery and equipment to deal with the spillage.

Inform others
Inform the Forest District Manager who will need to know a number of facts.
a) *Any injuries and any action required regarding safety?*
b) *The exact location of the spillage.*
c) *How much has been spilled?* When in doubt, err on the high side. It is often difficult to gain accurate information from those already there. If the persons on site have been involved in an overturning or a traffic accident, they will be shaken up at least, and might be tempted to minimise or reduce the degree of the spillage. If no-one is on site, the driver may have gone to seek assistance. Assume the worst: if the tank or drum is empty, work on the principle that it was full.
d) *How far has it travelled?* (If this is not immediately obvious, then ensure that the incident is reported before trying to determine the downstream limit.) This is an essential first step in dealing with the spill. It is imperative that the downstream limit of pollution is established at the outset of control operations. Prevention of further spread of the pollutant is the first priority and operations should start at this point.
e) *Who else needs to know?* Which neighbours downstream are threatened by the spill? The District Office will notify the River Purification Boards and neighbours as appropriate. Give as precise a description of the spill as possible, where it started, how far it has reached, and where you propose to start operations to contain it. If possible, give its speed of progress and a realistic assessment of the chances of containing it.
f) *What are we dealing with?* There may be more than one pollutant involved. Both forest and haulage machinery may have hydraulic oil tanks capable of containing 100 litres or more in addition to fuel tanks. Hydraulic oil may not flow quickly on its own but when mixed with fuel oil the speed of spread will be greatly accelerated.

2. Dealing with the spill

Using oil absorbent materials
Straw bales are cheap, provide some absorption qualities and can quickly be used to block drains and small streams.
Sheets (pads) can be placed over the oil, particularly once the flow has been slowed in drains, watercourses, ponds, etc. Caution is needed to ensure that the sheets do not blow away before being fully saturated.
Pillows containing loose fibre can absorb a relatively high volume. A pillow should be used to absorb contaminants from a leaking pipe while the source is isolated. This also applies to drips from machines, eg from sumps.
Booms can be laid on the surface of drains and streams. They are most effective in pools or slow moving reaches of water. They should be arranged in a curve across the surface and the ends secured to the bank on either side and upstream of the base of the curve. A small boom 18 cm in diameter and 1.5 m long will absorb up to 35 litres of oil. Booms can be joined by means of tapes on either end but an overlap must be made at each joint.
Absorbent pads and cushions can be placed on the upstream side of the boom or in isolated pools. They are very effective in absorbing oil from the surface and can be replaced when saturated or in emergency wrung out into containers and re-used.

Diverting the flow and constructing dams

If available, a back-acting digger or equivalent can throw a dam across a drain or minor stream very quickly and the polluted water diverted to a less sensitive area or a holding area to be dealt with later. Where possible, a pipe can be incorporated near the base of the dam to allow clean water to flow out and the oil can be skimmed off the top with pads or cushions (*Figure 3*).

A series of these dams with pipes at the bottom can be an effective means of gradually cleaning the flow over a short distance, if placed 10-20 metres apart. The flow of water through the pipes must be regulated to maintain sufficient depth behind each dam and to prevent the level over-topping the dam. A simple sandbag placed over the upstream end of the pipe allows water to build behind the dam and, when sufficient has accumulated, the bag can be adjusted to allow the desired amount through the pipe (*Figure 4*). Allow for changes in stream flow, by visiting during changes in weather during the cleaning operation.

When machinery is not available for dam construction, sandbags, stakes and boards can be used to construct a serviceable dam by hand.

If a stretch of drain or stream does become polluted before containment can be achieved, then the construction of a series of dams is the most cost effective method of mopping up oil. It is impossible to get to oil spread thinly along the sides of a drain or stream over a considerable distance. The dams can be used to trap oil because it flows downstream over the coming weeks and makes clearance straightforward.

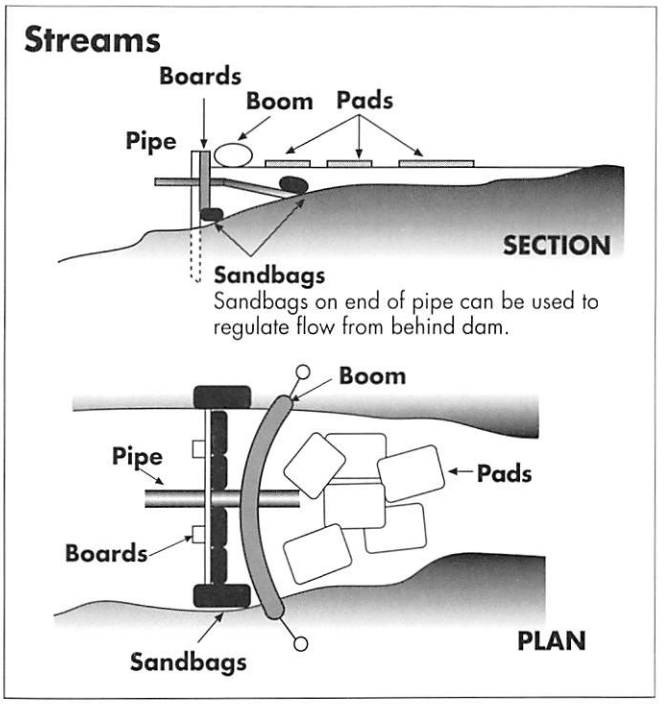

Fig. 4 Temporarily restricting water flow in ditches and culverts to allow oil removal with absorbent pads.

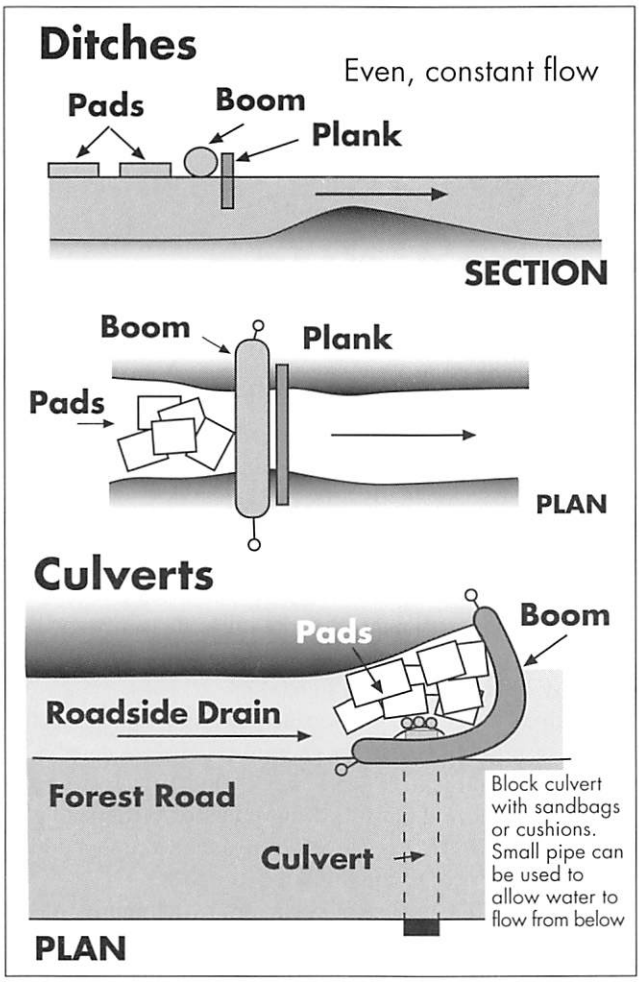

Fig. 3 Temporary dams to contain an oil spillage may be constructed with boards or using earth, with a pipe through.

Constructing a large boom

Despite efforts with oil absorbent materials and dams, oil may still get past these defences and threaten major watercourses, ponds, lakes or reservoirs. In these circumstances, a large boom may be the answer (*Figure 5*). A number of smaller booms can be joined together across the confluence of a stream with a river, or at the point at which the stream enters a lake. It will be necessary to pass a rope across the stream at this point and haul the string of booms from bank to bank or to tow the booms out into the lake with a boat and travel in an arc to the far bank. Whichever method is used, each end will need to be firmly anchored to a tree or a stake driven into the ground.

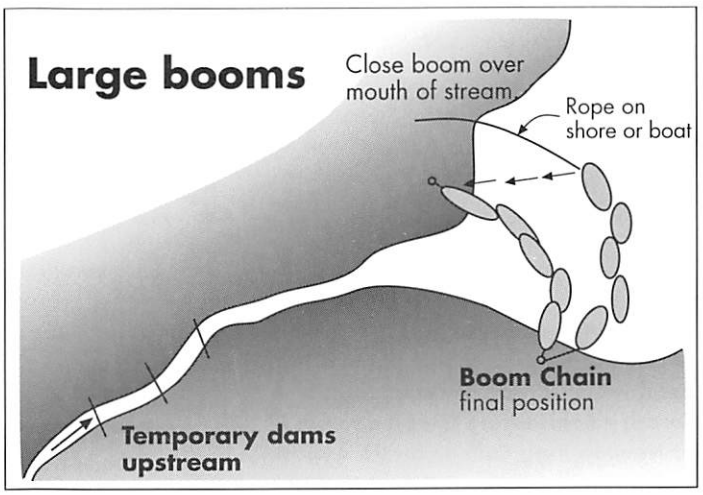

Fig. 5 Use of large booms in ponds or reservoirs to minimise the contamination of areas of slack water.

Appendix 2 - Suppliers of oil absorbent materials

Swan Corporation
Moorbridge Works
Bestwood Road
Bulwell
Nottingham NG6 8SS
Tel: 01602 751768

Crest Flowline Ltd
163 Stowvale Road
Southbourne
Bournemouth BH6 5HQ
Tel: 01202 425000

Omnifield Ltd
The Granary
More House
Wivelsfield Green
East Sussex RH17 7RE
Tel: 01444 471683

Oil DRI UK Ltd
Bannisters Row
Wisbech
Cambs PE13 3HZ
Tel: 01945 581244

K N Services
Main Street
Balbeggie
Perth PH2 6EZ
Tel: 01821 640201

Darcy Products
Invicta Works
East Malling
Kent ME19 6BP
Tel: 01732 843131

This paper was presented at the IAgrE conference entitled: "Prevention of pollution during forest engineering operations", organised by the Forestry Engineering Group and held at Newton Rigg College on 31 August 1995. David Jardine is Forest District Manager, North York Moors Forest District; Steve Penny is District Forester (Operations), Borders Forest District; and all are on the staff of Forest Enterprise, the part of the Forestry Commission responsible for management of the forest and woodlands owned by the nation. The contact address for the leading author is
Forest Enterprise,
North York Moors Forest District,
42 Eastgate,
Pickering
North Yorks,
YO18 7DU

Engineering Guide

The Ivanhoe Guide to the Engineering Profession 1996 is now available. Published in association with The Engineering Council, the **7th edition** of the guide provides undergraduates and young professionals with an excellent and in-depth insight into the world of the professional engineer and the career prospects engineering offers.

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Pesticide residues

The latest surveillance of pesticide residues shows that the vast majority of pesticides are being used correctly and in line with good agricultural practice. Analysis of 3,700 samples from a variety of foodstuffs showed that:

* 69 per cent did not contain detectable pesticide residues
* 30 per cent had residues below the maximum residue level (MRL)
* only one per cent had residues above the MRL.

Commenting on the results, Food Minister Angela Browning said: "Despite the fact that the monitoring programme is specifically targeted at foodstuffs which are most likely to contain residues, 99 per cent of the samples analysed had no residues or were below the recommended MRL. This is particularly encouraging at a time when the Pesticides regulations introduced in 1994 are increasing the number of pesticide/commodity combinations covered by MRLs from 1,000 to 6,000."

Residues of organochlorine pesticides were detected just above the reporting threshold in 66 of 216 samples of milk. Residues of gamma-HCH were detected in 30 per cent of the samples. Whilst no residues were above the MRL, a survey of milk, plain and white chocolate was carried out following previous media and consumer interest in the levels of gamma-HCH. Low levels of residue were found in 82 per cent of the UK samples and 40 per cent of the imported samples.

The report highlighted the possible misuse of pesticides by a minority of UK lettuce growers. An enforcement programme was carried out between November 1994 and February 1995 when 48 samples collected randomly were analysed for the presence of two prohibited fungicides - vinclozolin and chlorothalonil. As a result of that programme, five case are currently under legal investigation.

Continued action against farm waste pollution

The Minister for Rural Affairs at MAFF, Tim Boswell, has announced that more farmers in selected river catchments in England, are to be offered help in making better use of their organic nutrients, and in tackling the problem of water pollution from farm wastes.

Seven areas will be targeted in intensive campaigns promoting farm waste management plans, and farmers in each area will be given free assistance by ADAS. The new areas comprise part or all of the following river catchments:

the River Derwent in Cumbria; the Middle and Lower Nidd near York and the Eastern Vale of York; Ash Brook and Rookery Brook in Cheshire near Crewe; the Mid Dove centred around Ashbourne in Derbyshire; the River Yeo and the Upper Parrett near Yeovil in Somerset; and the River Dart in South Devon.

Farmers will be encouraged to prepare their own individual management plans for spreading manure, and other similar organic wastes, on land in the most economical and environmentally friendly way. The plans will assist farmers in deciding where, when and in what quantities they should apply wastes in order to minimise water pollution, and maximise the benefit from the nutrients in them. All the farmers in these areas will be invited to attend meetings to launch the campaign and to explain their involvement.

Announcing the new campaign Mr. Boswell said: "The responses to previous campaigns to promote the use of farm waste management plans have been very encouraging. Farmers are recognising that following a plan maximises the nutrient benefits from farm wastes whilst minimising the possibility of water pollution. Sound farm management practice is the key to reducing farm pollution further."

Massey Ferguson speeds product planning

The need for better strategic planning, full simulation and faster manufacturing resource planning (MRPII), combined with the pressures of product development, has led the British tractor-making subsidiary of a world-leading corporation to replace ageing mainframe software with an advanced UNIX client/server manufacturing, planning and control system.

Massey Ferguson Manufacturing Limited, based in Coventry and a subsidiary of the international AGCO Corporation, awarded a major contract to Parallax, also based in Coventry, for the fast-growing software developer's Advanced Planning System (APS), a highly integrated suite of manufacturing planning and control software. APS will allow Massey Ferguson to plan over a much longer term horizon than with the present mainframe system, and it will provide the opportunity to improve inventory forecasts. The software will also enable manufacturing resource planning (MRPII) to be run in a far shorter time.

Using the company's previous system, it was only practical to provide projections for up to nine months, whereas the tractor needs at least a year and a half. APS is well able to exceed this timescale. Furthermore, weekly MRPII reports on the existing system may take a weekend or longer to produce, but thanks to APS will provide the required data in minutes.

In addition, APS will enable all-important simulation or 'what-if' modelling of strategic business options, which will offer an optimising capability hitherto unachievable on the mainframe system. With the new software, it will be possible for Massey Ferguson to be more pro-active in planning, extending from the strategic level right down to the shop floor.

Alan Deeley, the company's Systems Development Manager, explained why APS was chosen: "We looked at other UNIX-based manufacturing planning and control systems, but none offered the high level of strategic planning, valuable simulation or outright speed capabilities of APS. The system also operates on a 'closed loop' basis which provides a feedback of data encompassing many aspects of the supply chain process, an important feature of MRPII processing.

"Furthermore, because of production pressures," adds Deeley, "we also wanted a system that is entirely proven and reliable. APS has achieved this record already in many industrial sites worldwide."

APS will also provide a number of other functional improvements to the business.

Specification control - APS will be used to instantly identify unique and common items within the bill of material(BoM) to ensure that product design changes are implemented at the optimum time, thus minimising material obsolescence.

Demand pegging - The new system will provide the ability to trace back low level requirements to the originating customer order, enabling Massey Ferguson to become more pro-active in determining which specific customer orders may be affected by material requirements such as component supply problems.

Capacity planning - The opportunity to assess the impact of various demand streams on different manufacturing cells will be possible, so that potential bottlenecks in production may be identified.

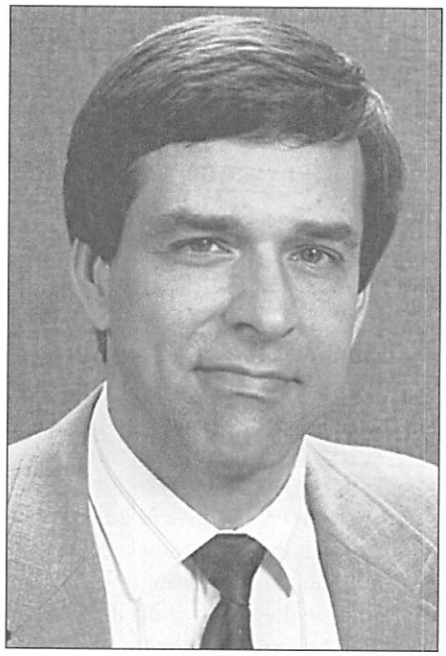
Integrated MPS - APS will enable the master production schedules (MPS) to be consolidated into a single plan and to be run dynamically with integrated MRPII. As a result, Massey Ferguson will be able to compare high level business plans with detailed work schedules to operate the business more effectively. Currently, different areas of the business are being managed by separate implementations of a PC-based master production scheduling (MPS).

The Parallax contract includes both the supply of the APS software and an IBM RS 6000 UNIX processor serving a number of other workstations running on a Token Ring network.

The path to environm friendlier turf equipm

Marvin B Jaques

The path to environmentally friendly turf maintenance products begins with equipment users showing a preference for such products, or legislation requiring such products. Unfortunately, all too often, legislation is required as manufacturers and users wish to avoid the additional costs and/or inconvieniences of such products. The Ransomes E-Plex is an example of how we can work together without the threat or burden of legislation to design and produce machines needed to maintain managed turf areas with minimal impact on the environment.



This paper by Marvin Jaques, Vice-President Product Development, Ransomes Commercial, was presented at the meeting organised by the Amenity & Ecological Engineering Specialist Group and held in January 1995 during the British & International Golf Greenkeepers Association (BIGGA) Turf Management Exhibition

The path

The path begins with our commitment to leaving our environment in the same as, or better condition than, it was when we arrived. Those involved in the management of turf areas must demand and show preference for products that groom and enhance without damaging the environment. Manufacturers in our free market society, must respond to the needs and demands of their customers while protecting the environment during the manufacturing process.

Engineers and designers must adhere to all sorts of national and international legislation regarding the use or non-use of various materials and processes. We are all familiar with requirements governing the use of materials such as lead, asbestos, chromium, cadmium, fluorocarbons and so on. In some cases, elimination of these materials has compromised the form or function of the products used in turf management, at least in the short term, until substitute technologies are developed. In many cases, our industry follows the lead of the automotive industry in using environmentally friendly materials, components and processes. The automotive industry is currently very focused on increasing the ability to recycle their products. I believe that we too will be able to take advantage of developments that will allow our products to be recycled in a similar fashion. Actually, we've already begun by identifying, for recycling purposes, the type of plastic that we use in the rotomoulded plastic boxes used on our Turf Trucksters.

Less waste

We are investing heavily in our manufac-

entally ent

The Cushman Turf Truckster

turing facilities world wide to reduce emissions and decrease the waste that we send to landfills, or submit to other disposal techniques. Paint systems can and are being revised to reduce or eliminate volatile emissions given off during the curing of liquid paints. We favour powder paint systems as emissions are minimal, and overspray can be collected and recycled on site. Paint formulations, liquid or powder, can be formulated to eliminate the use of heavy metals and carcinogens. Organic based paint is in most cases more expensive than less desirable alternatives, and in some cases less durable. Scrap, where unavoidable, must be collected and correctly processed to maximise recycling. Component and finished goods packaging must be reduced or designed to be reused rather than sent to landfills or recycled in a less efficient manner. The use of fluorocarbons and other volatile solvents that are harmful to air quality or the environment is being eliminated or curtailed.

Turf care

Our customers have demanded reduced ground pressures and we have responded. The tyre size of the Cushman Turf Truckster increased from 18 x 9.50 to 24 x 13.00-12. This is one small example of how the market can dictate environmentally sound product designs.

The turf care industry, as well as several other industries, is investigating and testing alternative hydraulic fluids for use in machinery that exposes the environment to those fluids in the event of a spill. Vegetable oils and synthetic oils are prime candidates that still damage the leafy portion of the grass plant due to heat, but don't kill the plant and poison the soil if proper steps are taken after the spill occurs. Unfortunately, most of these alternative fluids are more costly to produce and acquire, and may require more frequent changes and operating temperatures. Danfoss, a well known European hydraulic component manufacturer has introduced water hydraulics. This concept requires additional expense in the hydraulic system to counteract the corrosive effects of water, but may find increased use in the turf care industry.

"manufacturers must meet the demands of their customers while protecting the environment"

Cleaner engines

Engine manufacturers, in response to legislation, have begun shipping lower emission engines. Diesel and petrol engines under 20 kW were the first equipment engines to be affected, with future legislation aimed at larger engines. The requirements become even tougher as we approach the turn of the century. The new engines require less maintenance and use fuel more efficiently. In most cases, the necessary changes have adversely affected acquisition costs of the engines.

The technical magazines are full of articles about alternative fuels for our internal combustion engines. Compressed natural gas, propane, and alcohol based fuels and additives are now being used on a limited basis. Engineered hydrocarbons and vegetable based, renewable fuels are being developed and/or tested.

Noise reduction

There has been a great deal of interest in noise pollution in the last 10 to 20 years. Excessive noise can damage our hearing permanently, and interferes with our ability to enjoy quiet moments and the natural sounds of our environment. Machinery operators must not be exposed to harmful noise levels produced by the equipment they operate. If safe sound levels cannot be achieved, protective devices must be worn to block the harmful effects of noise. Manufacturers have introduced improved silencers, sound deadening materials and reduced engine speeds to reduce exposure. Hydraulic component manufacturers have made design changes to their products to reduce noise emissions. Residents living near managed turf areas and users, such as golfers, have benefitted from manufacturers' efforts to reduce sound emissions. Local rules and legislation have been introduced to prohibit the operation of noisy machinery before certain hours or under certain conditions.

Electric power

Our industry, as well as others such as the automotive industry, has repeatedly investigated and, in some cases, tried to commercialize alternatively powered machinery. Interest in electric automobiles and mowing machinery is peaking once again. Electrically powered products have been limited in the past by range, weight, lack of refueling infrastructure,

and cost. Hybrid alternatives can help solve the range problem, but are even more cost prohibitive and more complex.

Ransomes has offered alternatives to internal combustion cylinder mowers in the past with mains electric and battery electric models. The market was not ready to accept the compromises necessary to make these products a success and they were eventually withdrawn from the market. Technological improvements have made electric mowing more practical by reducing the number of compromises that the user must accept.

Development of the Ransomes E-Plex

I understand that the triplex (triple cutting unit, ride-on type) greens mower was first introduced by Hahn in the United States. Ransomes began marketing the product under the Ransomes brand name, and eventually manufactured the product in the UK. The product evolved through development by a number of companies, to the petrol and diesel powered machines that we see on golf courses around the world today.

Interest in an alternatively powered triplex greens mower began in the summer of 1990. Thomas Stuart, then Vice President of Engineering at Ransomes, Johnsons Creek, Wisconsin, USA facility, commissioned an outside consulting firm to investigate the feasibility of such a product. Tom and the consultants felt that a hybrid powertrain would be necessary to minimise ground pressure and provide adequate range. Four alternative concepts were considered and costs estimated. The estimates indicated that a significant retail price increase would be necessary for the introduction to be profitable to Ransomes. This meant that the greens' superintendents would have to vote in favour of the product by purchasing the more expensive hybrid models over conventional, lower cost internal combustion models. The main advantage to the superintendents was elimination of potential hydraulic oil spills on golf course greens. Those of us in the industry know that golf greens are considered "holy ground" by those in the golfing industry. Golfers have become increasingly particular about the putting surfaces.

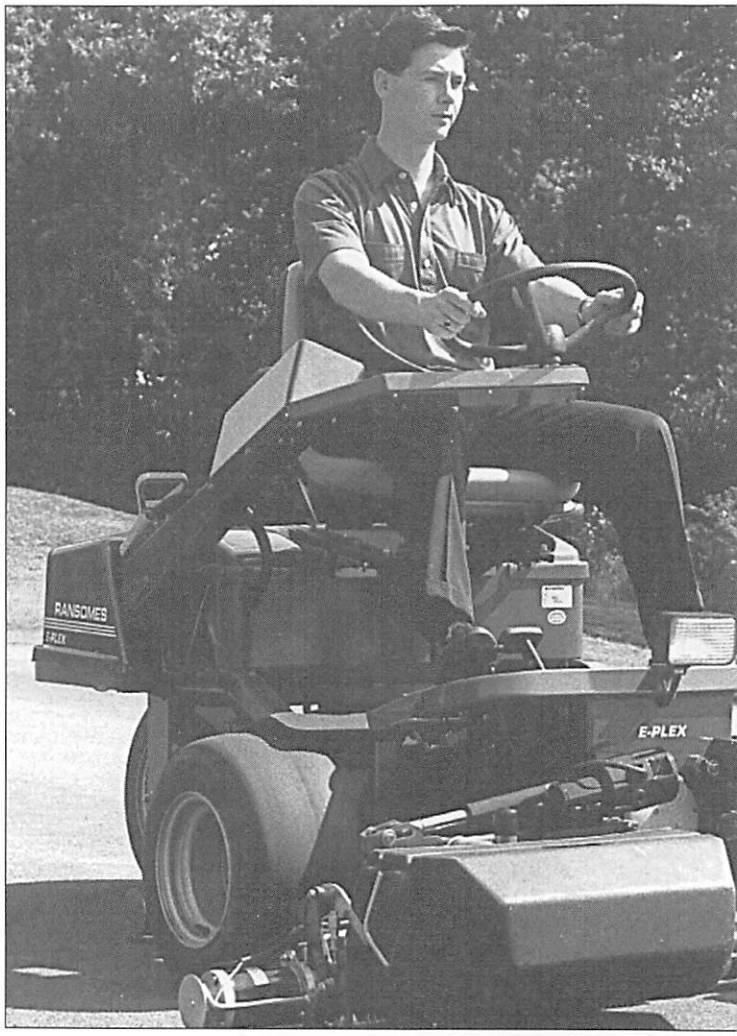
In the summer of 1992, Tom Stuart and I initiated a further investigation into the feasibility and market potential of an electrically propelled triplex greens mower. We consulted with a number of potential vendors of electric components to determine if they had the technology to economically supply component solutions for such a product. We determined that the technology was available and that the cost of some of the components had become a bit more reasonable. The decision was made that summer to further research the feasibility of the concept by building a battery powered test mule to gather data on range and power consumption. Our first tests, conducted with only a single electric cutting unit, demonstrated that we had overestimated the power required to electrically drive the cutting units. We continued to gather data with a three unit test mule. It still appeared that a 36 volt hybrid system with all of its complexity and costly components would be required.

In the spring of 1993, one of our engineers at our Cushman facility in Lincoln, Nebraska, deduced that a 48 volt system using high energy lead-acid batteries would have enough range to cut nine large greens on a long golf course, and 18 greens on an average length course with average sized greens. This concept reduced the estimated cost of an electric model to approximately the same cost as a petrol driven model. Weight was still a concern due to carrying nearly 270 kg of batteries when traversing the "holy ground".

no danger of oil spills and reduced noise are key advantages

Market research

In the meantime, market research, carried out with surveys and interviews with greens' superintendents, indicated that there would be a great deal of interest in an all-electric product. In addition to the elimination of hot hydraulic oils, we learned that noise reduction, reduced maintenance, reduced operating costs and longer product life were equally important. Golf course managers were already in conflict with surrounding property owners and neighbourhood associations who want to restrict noise due to mowing of the greens until after eight or nine o'clock in the morning. This meant that the courses either experienced lost revenue due to later opening hours, or had to mow while the golfers played. We learned that keeping a greens mower operating well without leaking oil was quite a chore, regardless of the manufacturer, and was expensive. Many courses only used greens mowers on the greens for two years, then



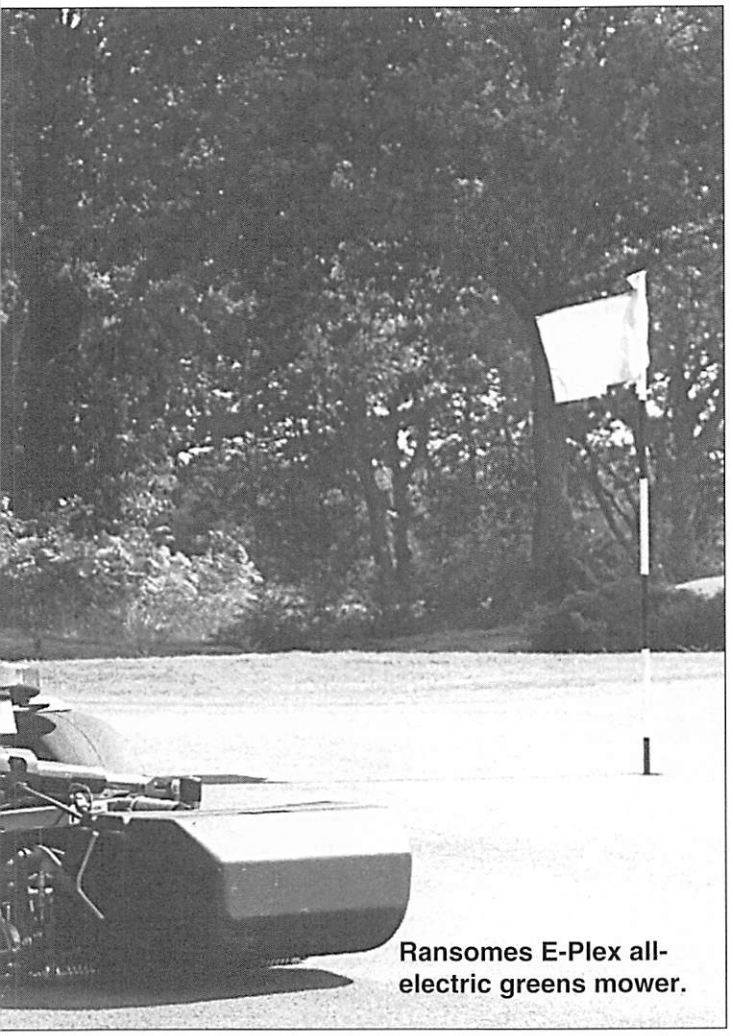
moved them to tees and collars for fear of hydraulic oil leakage. Catastrophic leaks, such as broken hoses that carry oil to the cutting unit motors, can mean rebuilding part or all of a green.

Prototype testing

Prototype units tested in Florida revealed that a 48 volt all electric greens mower could mow 23 or 24 average sized greens on an average size of golf course without recharging. Range is reduced on hill courses, during low temperature operation, and if the batteries are poorly maintained or are old. We determined that operating costs for our electric greens mower would be less than for a typical internal combustion powered model including twice yearly replacement of the battery pack! Courses with later opening hours due to noise restrictions can pay for an E-Plex in just a few weeks with the added revenue from earlier opening.

We found that our E-Plex was only slightly heavier than a diesel model. The use of larger tyres being used by one of our competitors on their diesel model allowed us to achieve approximately the same ground pressures as the average petrol driven model.

It turned out that our biggest challenge came in an area that we did not anticipate. We had trouble achieving our life goals on the electric lift mechanisms. Samples submitted by our first supplier would not last a season. Our second vendor was committed to developing a lift actuator that would last a minimum of three seasons of average use. A number of changes to the vendor's standard product were required before we were able to achieve our life goals using accelerated round-the-clock testing. The component that we use today is costly, but gives a reasonable number of cycles before being rebuilt or replaced.



Ransomes E-Plex all-electric greens mower.

Most of the electric circuitry is contained in a box mounted in the floorboard. The controller and relays are simple industrial vehicle and automotive type components. An electronic timer delays lowering and raising the centre reel as the machine enters and exits the edge of the green. Waterproof connectors prevent corrosion and electrical "leaks". The entire box can be removed for repair, diagnostic work, or replacement if necessary. Control panel rocker switches are marine quality, and sealed to prevent water damage.

Pilot production of the E-Plex was completed in the Autumn of 1994 and full production commenced in October of that year. Market acceptance has been incredible, a huge success.

Where do we go from here?

We believe that our customers will be pleased with the product that we currently produce, but will tell us what we can do to satisfy their needs even further. The next generation product should incorporate our customers suggestions, technological advances, and improvements developed by our engineers and vendors.

Battery technology does not seem to be advancing as fast as advertised. High technology batteries under development are costly, and some are quite dangerous to be around. It appears that lead-acid technology will prevail in our industry for the forseeable future. There are advancements coming in lead-acid technology that reduce maintenance and increase energy density by up to 50%. According to lead-acid battery manufacturers, 95% of the lead in their batteries is recycled. I believe that number could approach 100% if proper incentives were applied by the battery industry, or through legislation.

I expect that you will see this technology applied to other turf management machinery in the near future. Our E-Plex customers will help determine which products will be next, through their E-Plex experiences, and by expressing their needs. We at Ransomes hope that we can avoid the need for additional environmental legislation regulating turf management machinery, by listening closely to our customers, and protecting our environment.

CE marking of installations

A lively response from the manufacturing side for a common sense approach

Dear Sir,

I feel that I must take issue with you on the article '**CE** Marking of Installations' in the Autumn issue, 1995. Since this is published without comment in an authoritative publication such as this, I must assume that it is intended to represent factual guidance for the trade. *(There is no Journal censorship of contributor's opinions, only editorial discretion: see standard disclaimer on Contents page, Ed.).* Whilst I would not consider myself to be an authority on the requirements of 'The Supply of Machinery (Safety) Regulations', it appears that the article cannot be factual, proposes impractical techniques and seriously underrates the quality of the majority of installation companies within our industry.

Manufacturers must obviously provide quality, essentially safe, equipment. Since the type of equipment referred to in the article will usually be supplied for incorporation within a larger 'machine' by others, they must supply appropriate instructions and guidance both for the correct and safe installation, and for the subsequent use of the equipment. (This, of course, includes carrying out the necessary risk analysis and correctly issuing CE marks and Certificates of Conformity or Incorporation, as appropriate.) Unless they are specifically consulted, machinery manufacturers will have little or no knowledge of the design or installation of the plant into which standard items of equipment are to be incorporated and it must be assumed that the installation will be in accordance with the instructions and information provided.

Safety of an installed machine will usually be dependent upon another piece of 'equipment' supplied from a different source. For illustration, take an elevator of one manufacture feeding a conveyor of another manufacture (there may well be sound reasons for not buying both from the same manufacturer). The outlet of the elevator and the inlet of the conveyor will both be supplied open (they have to be otherwise the product cannot get out of one and into the other) and, in the open state, would be inherently unsafe. This application is made to work by the installer fabricating a special interconnection, or fitting proprietary items of ducting, by perhaps a third manufacturer, between the two. This will carry the product and make the plant 'safe'.

Who, is it suggested, would take responsibility for the safety of this particular connection: the manufacturer of the elevator who will have no knowledge of the interconnection; the manufacturer of the conveyor who will equally have no knowledge of the interconnection; or the manufacturer of any proprietary ducting who will have no knowledge of either machine? Perhaps a meeting of all three on site to inspect and agree would be sensible. This could be tied in with all the other manufacturers/suppliers of items of equipment on the plant to inspect all the combinations of equipment. At the full gathering of the assembled throng, *irrespective of cost and practicality*, a consensus could be achieved and a Certificate of Conformity could be signed by all parties! This interpretation appears to invent requirements which are unnecessary and impractical.

As I understand it, the Regulation requires **Manufacturers to supply Certificates of Incorporation for their own items of equipment** and for the **Plant Designer/Installer to certify and take responsibility for the overall plant** which he has designed/installed. This appears to me an eminently sensible and practical arrangement. If a final customer/user wishes work to be undertaken by a particular business which does not have the necessary expertise to CE mark the work and issue a Certificate of Conformity, then it must be realistic for them to employ an independent consultant to carry out an inspection and advise the installer.

The article implies that the normal installer is lacking in expertise and resource, and is incapable of carrying out his responsibilities. This, I feel, is a serious slur on the qualities of the vast majority of suppliers/installers of this type of equipment who, in my experience, have a huge and valuable fund of professional knowledge and expertise to offer their customers. It is also totally unjustified to state that the manufacturers/machinery suppliers are, to quote, 'turning a blind eye' to legislation because they do not take over the legislative requirements of those customers who are unable or unwilling to follow the correct compliance procedures, and again to quote from the article, 'if indeed they are even aware of their obligations'.

I am certain that the vast bulk of the manufacturer/machine supplier section of our industry carry out **their** responsibilities under the Regulations with diligence, both factually and in the spirit of the requirements, and are only too willing to assist their customers in any reasonable way.

Yours faithfully,

Clive Simpson MIAgrE
Technical Manager
Carier Bulk Materials Handling Ltd

Membership Matters

Quarterly The newsletter of the Institution of Agricultural Engineers Winter 1995

Personal Career Development

The PCD focus and benefits to employers

Waiting for a dental check-up the other day, I was casually reading a late 1970's edition of *Punch* when I came across a definition which caught my attention. It was as follows.

ENGINEER'S DROOP: a chronic down-in-the-mouth expression occurring in engineers conscious of the low regard in which they are held by the community.

We might debate the extent to which this definition applies some twenty years after it was written. What the community as a whole think about us is, of course, important. Of even greater importance is the assessment of engineers made by employers. Whether in the private or public sector, employers have had a challenging time during the past two decades. Those employing agricultural engineers have been as greatly affected as any by change and economic restraints. This has meant that fewer people, including engineers, are now employed in the traditional sectors of our industry. Those who remain are under ever increasing pressure to deliver more effectively and efficiently, supported by the minimum of resources.

Associated with these dramatic changes, however, there are positive indicators for the future. Our industry is expanding into new areas of science and technology, creating products and systems often with the assistance of a new breed of agricultural engineers. New employers are thus entering the industry, bringing with them new opportunities and high expectations of their employees. Alongside these new employers, it is encouraging to see a steadily growing number of traditional employers successfully making the transition necessary to meet today's requirements.

Against this background, the mutual benefits of PERSONAL CAREER DEVELOPMENT to both individual engineers and their employers is very clear. It is essential that engineering staff are fully acquainted with the latest advances in science and technology relevant to the employer's business. A steady flow of new ideas and key information is a vital ingredient of all leading and successful companies. Maintaining contact with the industry's "movers and shakers" is an efficient means of keeping in touch. All of these requirements - and more - can be met through The Institution of Agricultural Engineers CONTINUING PROFESSIONAL DEVELOPMENT scheme.

So, the message to Institution members is: *"Personal Career Development and Continuing Professional Development are valuable to you and to your employers - **so use it!**"*

To employers we say: *"First check that your engineers are members of The Institution of Agricultural Engineers and that they are bringing to your business the benefits provided by Personal Career Development and Continuing Professional Development."*

We urge employers and all engineers to think positively together and to seek maximum exploitation of the potential that your business, products and services offer. Above all, avoid *ENGINEER'S DROOP* in all its forms and at all times!

Professor Brian A May

Practice what you preach

Dr Peter Cowell has taken another stride along the career track and, after many years at Silsoe College, has moved to Lancashire to look after the family farm. .....It was gleaned from a normally reliable source that Peter may well be evaluating a concept design for a new generation of land-based equipment. Internationally respected for his work on tractor linkage geometry and control systems, it is conceivable that Peter is developing a unique front wheel drive tractor, equipped with front linkage but driven primarily backwards. This would take some of his early research at Newcastle full circle. Based on past experience, our Science Correspondent confirms that it there are no insurmountable design problems, although obviously there would have to be major modifications to the driveline, linkage convergence and weight transfer to attain peak performance from this tractor/implement combination. Off the record, he was attributed to have said: "With 'hindsight', the operator's forward vision is completely unobstructed and opens the way towards a rapid increase in field operating speeds."..... Peter, we acknowledge your real research and teaching contribution in Agricultural Engineering, and wish you well in your future activities.

BDW

Claude Culpin OBE, MA, FIAgrE

Claude Culpin, a former President of the Institution and holder of the Award of Merit, died on 11 November 1995. He was 85, and was in his 50th year of membership.

Claude was brought up near Wisbech, and from 1928 read Natural Sciences and Agriculture at Cambridge, where the School of Agriculture was at the height of its national and international reputation. He went on to teaching and research in agricultural engineering in the School of Agriculture, and published work which still stands as of major importance. When his career appeared to be moving more into plant physiology than engineering he made the positive decision to make engineering and mechanisation his central interest, and this remained so for the rest of his life. He was sincerely attached to his college, St John's, and maintained the contact right up to the present year.

During the War, he was County Agricultural Organiser for Worcestershire, helping the drive for greater food production, and immediately afterwards was involved in the development of the Nuffield, later to be the Leyland, tractor. With the establishment, just after the War, of the National Agricultural Advisory Service, forerunner of ADAS, he became Chief Mechanisation Adviser, based at Wrest Park, Silsoe, where the National Institute of Agricultural Engineering was newly arrived from its wartime base at Askham Bryan. On retiring from ADAS in 1972, he was Technical Consultant to the AEA for 8 years, and from 1974 also devoted his energy, as Honorary Consulting Engineer to the RASE, to the development of the Machinery Award Scheme. Under his guidance, the stature of the Scheme, and the prestige attached to the award of gold and silver medals, was transformed. Throughout his life he was a keen and talented sportsman, playing soccer for the St John's first team and for Cambridge City, as well as tennis, cricket, squash and golf. His other great interest was gardening, which he did with meticulous attention to detail.

Claude Culpin was best known for his book 'Farm Machinery'. First published in 1938, this went through 12 editions, the final one published recently. Culpin's Farm Machinery can be found in colleges, research stations, libraries and offices world-wide, and is the standard first-call reference on farm machinery. Through it, and a further three books on the more specialist topic of machinery management and costing, the Culpin name has been familiar to generations of agriculturalists.

We offer our sincere condolences to Mrs Vera Culpin and her family, and give thanks for the contribution made to agriculture by Claude Culpin over the past 60 years.

JBF

William D Akester, OBE, Hon FIAgrE

Mr William D Akester, OBE, Hon FIAgrE, died in early August in his 87th year. Bill Akester, as he was known to his many friends, was educated at the Ipswich Municipal School and joined Ransomes, Sims & Jefferies Ltd at Ipswich in 1925 as a junior clerk. He joined the retail department in 1928 as a demonstrator salesman and moved to Edinburgh in 1934 as Ransomes' first Scottish representative for agricultural machinery. Lawnmowers were added to his remit four years later.

During the war years, he was personal assistant to Sales Director Henry Deck, and then became home Agricultural Sales Manager. He also served as 'F' Company Commander of the 11th Battalion of the Suffolk Home Guard. In 1950, he was appointed to the Board as Home Sales Director and, in the same year, he also joined the Boards of RSJ (Scotland) and RSJ (Watford) Ltd. For much of his career at Ransomes, which included the award of OBE for services to exports, Bill Akester was assisted by his sister Lottie.

He was a member of the Institution of Agricultural Engineers for over 35 years and also served on the Councils of the Agricultural Engineers Association and the Royal Agricultural Society of England.

BJB

Peter Wakeford, CEng, FIAgrE

Peter Wakeford died on 3 November aged 79. He was an electrical and agricultural engineer who devoted the whole of his career to the development of electricity and electrical applications for agriculture. His many achievements included the production of Farm Electric Centre handbooks on controlled environment for livestock, feed preparation on the farm and the transfer of technology. Most of the technical books on livestock housing include sections of Peter's original work. He also directed a wide range of research and development projects as the Electricity Council's national livestock specialist and handled technical enquiries from farmers, advisors and students. He was always enthusiastic and very well known both in agriculture and throughout the electricity industry. For the last 5 years of his career, Peter managed the Electricity Council's Farm Electric Centre at Stoneleigh. He retired in 1981.

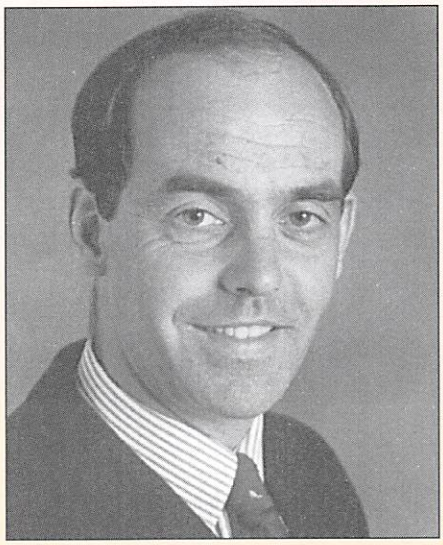
Peter was always very thorough and professional in the engineering aspects of his work. He will be remembered for the way he looked after his staff and for the excellent relationships he had with everyone he met and worked with. He was a career engineer who was also a practising Christian. All who knew him, remember both his kindness and a unique ability to bring out the best in those he met. Peter was involved in The Institution of Agricultural Engineers throughout his career and was also active in CIGR representing the UK on many occasions.

He kept in touch with the Farm Electric Centre staff throughout his retirement and gave encouragement when the Centre went through privatisation of the electricity industry. Peter made many more friends in his retirement and enjoyed a very happy time with his family.

CDM

Waste management across the pond

Farmers in the USA are well ahead of their UK counterparts in the management of farm waste. That was one of the key findings for **Dr Andrew Landers**, Head of Engineering at Harper Adams Agricultural College, Shropshire. He has just returned from an eight week tour of North American farms across eight States on a Winston Churchill Fellowship. The Winston Churchill Memorial Trust established the travelling fellowship scheme to enable citizens from all walks of life to gain a better understanding of the lives



and work of people in other countries, and to gain knowledge and experiences which will make them more effective in their work and communities when they return.

Stricter environmental controls, especially in groundwater protection, have resulted in the development of more innovative engineering solutions to USA's farm waste problems. Andrew studied various methods of reducing groundwater pollution from manures, pesticides and fertilisers and highlighted some which are particularly relevant:

- *a pesticide container scheme through which the containers are collected, chipped up and turned into fence posts;*
- *less input of pesticides and fertilisers by the use of precision farming techniques which involve a field survey to identify the level of inputs for each part of a field, and a cab mounted computer using satellite navigation systems to vary automatically the input level required;*
- *use of high pressure steam sprays to control insects and diseases in apple orchards, eliminating the use of pesticides;*
- *on-farm composting of chicken carcasses, and even of pig carcasses;*
- *use of a government sponsored scheme called 'Farm-A-Syst' which pays for a farm pollution audit and for follow up advice on pollution control and management.*

Institution membership changes

Admissions - a warm welcome to the following new members

Member: S D Evans (Derbys)

Associate Member: C M Bentley (Wilts), P Davies (Cambs), G B Lovelace (Herts), S V Nepomnyashchaya (Ukraine)

Associate: A Cooper (Bucks), J E Gibbs (Devon), V A Hammond (Scotland), L Hannell (Yorks), A G Robbins (Scotland), M P Roding (Scotland), I Sutherland (Scotland)

Student: L Anota (Beds), C D Boreham (Beds), W Bowden (Beds), Md Ali K Ghazavi (Tyne & Wear), T Gyamtsho (Beds), Y Persaud (Beds), M W Peters (Devon), A D B Shorten (Beds), S D Vaughan-Jones (Beds), S W Wise (Beds)

Reinstatement: D W Barraclough (Leics), E O Siwoku (Lancs)

Transfers - congratulations on achieving a further phase of their professional development

to **Fellow:** P C Baker (Wales), M J Copeland (S Africa)

to **Member:** A P Casebow (Guernsey)

to **Associate Member:** K N Baguant (Mauritius), S R Briggs (Oxon), J D Cain (Cheshire), V R Emerson (Wilts), P N Leech (Lincs), S G Williams (Wales)

to **Associate:** L C Ashmore (Ireland), K N Baguant (Mauritius), A A Ball (Derbys), A G Bell (Cumbria), S R Briggs (Oxon), C Broughton (Scotland), J E Brown (Cambs), G Dart (Yorks), S J Dicks (Northants), J M Greatorex (Beds), A M Green (Cheshire), N A L Gunn (Kenya), S R Honeywood (Suffolk), R Horsley (Yorks), A J Hoskins (Worcs), A Kaminski (Warwicks), J A Kinston (Derbys), B Kotschoubey (London), H C Leigh-Firbank (Somerset), D T Messenger (Scotland), D J Robertson (Scotland), M Rubbis (Italy), N G Skelton (Scotland), R Spark (Scotland), Y Sun (Beds), L W Thomas (Wales), R J Tonks (Shrops), T W Waine (Herts), M J Wattam (Hampshire), Y Wei (Beds), P M Wightman (Tyne &Wear), S G Williams (Wales), R Yates (Scotland)

Deaths - with great sadness we record the deaths of: C Culpin (Beds), W D Akester (Suffolk), B Bernard (Wales), P A M Murray (Gloucs), P Wakeford (Norfolk)

Engineering Council registrations

EngTech: R L Grantham (Shrops), W W Kinnaird (Scotland)

Jim O'Callaghan and his wife holding the retirement gift, with Ian Yule (left) and John Gowing (right) who jointly organised the international conference.

Professor J R O'Callaghan

Jim O'Callaghan retired on 30th September 1995 after almost 30 years as Professor of Agricultural Engineering at the University of Newcastle upon Tyne. His retirement was celebrated, together with other important landmarks in the teaching of agricultural engineering at Newcastle, by an international conference and a reunion of former students (both reported elsewhere).

Jim graduated from the National University of Ireland and first came to Newcastle (then King's College, Durham University) in 1952 to research into the drying of wheat. He departed briefly to Ford Tractor Division and to a lectureship at University College Dublin, before returning to the Newcastle chair in 1966.

He is well known within IAgrE and the wider agricultural research community to which he has made a profound contribution. He was twice elected as Dean of the Faculty of Agriculture and also served from 1975 to 1984 as Pro Vice-Chancellor of the University. Most recently, he was Director of the University's Centre for Land Use and Water Resources Research.

JG

Membership movements - August to October 1995

Mem No	*Name*	*From*	*To*
2660	R Alcock	USA	Ireland
4172	M A Bird	Gloucs	Berks
4787	R H Berry	Kenya	Gloucs
6132	S R Briggs	Scotland	Oxon
6468	J D Cain	Cheshire	Notts
6386	D H Crowe	Wales	Cambs
6441	S R B Done	Beds	Lincs
5726	D S Elsworth	Yorks	Lincs
4850	M A M Gatward	S Africa	N'berland
3581	T J R Havard	Nigeria	Belgium
6289	N R Houseman	Hereford	Cheshire ***
4000	C G Irons	Hants	Dorset
5458	A H Knibb	Ireland	Oxon
6178	A M Lindsay	Beds	Warwicks
5972	M J Morgan	Philippines	Scotland
6017	S D Murphy	Suffolk	Beds
6418	J C Puddifoot	Nepal	Beds
5121	T Reeves	Leics	Derbys
5472	J N Short	Staffs	S Yorks
6262	K J Smyth	Warwicks	Beds
2412	R M A Stephenson	Oxon	Sri Lanka
5738	C B Waples	Wilts	W Sussex
3411	J C L Welwood	Albania	Scotland

*** N R Houseman was featured as "gone away" in the previous issue; he has now made contact.

Gone away

Name	*Last known address*	*Date*
R Yates	1 West Cottage, Duntarvie, Winchburgh, West Lothian, EH52 6QA	26/09/95

News of Members

Stuart Pearson has taken early retirement from the Welsh College of Horticulture where he was Head of Engineering. He is now working as an independent consultant in Nigeria. Stuart says that, after sixteen years in British education, he will be glad to leave and return to overseas work, having seen the decline of what was a sound and effective system of teaching, training and assessment of practical mechanical and basic engineering skills led by City and Guilds and BTEC. He is concerned that, in its place, we will soon have an expensive concept which depends more upon documentation than abilities and does not meet the training needs of the vast majority of practical mechanics and their employers, in particular, the smaller British companies.

Congratulations to **S R Briggs** who has been awarded an MSc in Soil Science from the University of Aberdeen, where he was sponsored as part of the ODA associate professional officer (APO) programme. He is now working in the Overseas Division at Silsoe Research Institute where he is taking various induction courses with the ODA before taking up a position in SW Uganda as part of the APO programme. When he goes to Uganda, he will be involved in monitoring indigenous soil and water conservation practices. Thereafter, he aims to pursue a career in overseas development either with the ODA or with another major technical aid organisation.

Michael Bird is continuing to offer freelance publicity and media relations services from his new address at Englefield House, Theale, Reading RG7 5EN, tel: 01734 303243. Michael specialises in agricultural, horticultural and sports turf mechanisation.

Neil Gunn has taken up a new job as production manager of a rose growing operation in Kenya and is involved in post-harvest technology.

Andrew Heather works for the Soil Survey and Land Research Centre (SSLRC) of Cranfield University as a research scientist. He is researching the behaviour of pesticides in the environment, particularly their effect on water quality and the impact on drinking water supplies. SSLRC have developed a geographic information system for assessing the vulnerability of water catchments to agricultural pesticide use. Part of Andrew's work is to test the system and to investigate its use as a management tool for improving drinking water quality. Some of his work will be submitted for an Engineering Doctorate with Cranfield University. The EngD is an enhanced PhD programme of four years, incorporating management training into a doctoral research project.

Tim Reeves is now back in the UK from Nigeria and is studying for a Masters degree in Business Administration (MBA) part time at Sheffield. He is also working in the Production Department of Fermec Manufacturing Ltd which makes Massey Ferguson industrial products.

Stewart Barton is working in Indonesia on The Second Integrated Irrigation Sector Project IISP-2. His duties are to "select and introduce appropriate machines and equipment for agricultural demonstration units in four provinces of Indonesia". These are small holder farmed, mostly growing paddy. He would like to hear from any members who have recent experience of manual or mechanical paddy transplanters, harvesters and strippers, and particularly wishes suppliers' names and addresses. For efficient communication, please contact him through his employer: ACIL Australia PTY Ltd, 854 Glenferrie Rd, Hawthorn, Victoria 3122, Australia, or fax: +61 3 981 94216, and marked: attention Judy Wilson for Stewart Barton, Mataram, Indonesia.

AAWC

Award winning student

James Cherry who attended the Warwickshire College of Agriculture on their Advanced Certificate in Maintenance and Repair of Agricultural Machinery was awarded the *West Midlands Branch Technical Trophy.* During his course at Warwickshire College, James designed and manufactured a loader mounted silage cutter grab which also can be used as a normal front end bucket.

Call to past students and staff of Lackham College of Agriculture

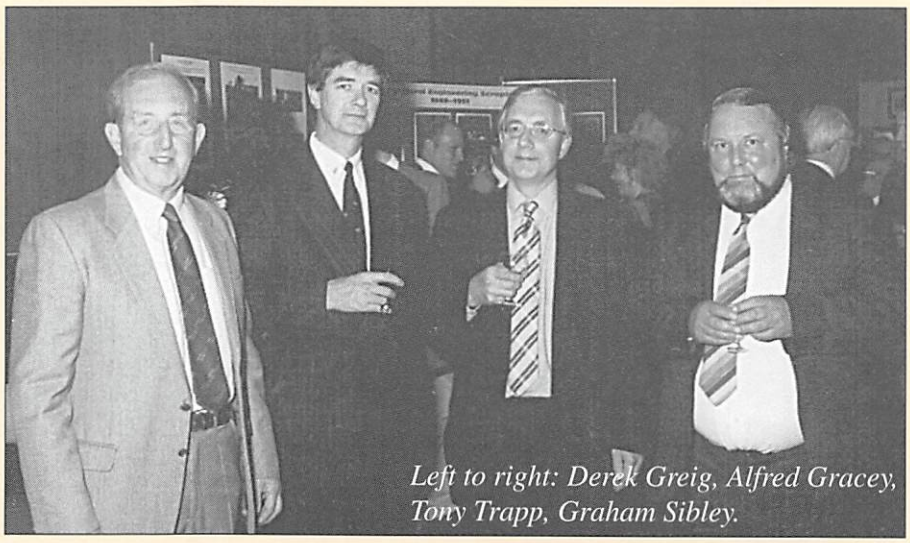
1996 marks the 50th anniversary of Lackham College of Agriculture and to mark this distinctive achievement, a Celebration Weekend is being organised for 6-7 July 1996. What an opportunity to visit old haunts, re-new acquaintances and view the tremendous changes which have taken place at your College since you were at Lackham. A dinner dance is planned for the evening of 6 July and this, together with other events to greet old friends, and to view the College's facilities, estate, workshops and farm, should ensure an enjoyable weekend away. Accommodation can be provided at the College for those travelling any distance. Those wishing to be added to the mailing list and receive further details should contact:

Peter Morris, Principal, Lackham College, Lacock, Chippenham, Wilts SN15 2NY, or fax: 01249 444474.

A 'jubilation' of Agricultural Engineers!

A reunion of agricultural engineering graduates at Newcastle University, 22-24 September, 1995. A look back after a look forward.

The occasion of the International Conference on 'Agricultural and Biological Engineering: New Horizons - New Challenges', held at the University of Newcastle upon Tyne on 19-23 September 1995 and reported elsewhere in this issue, provided a suitable opportunity for a reunion of King's College, and now University of Newcastle, agricultural engineering graduates. This was also an occasion for graduates to wish Professor Jim O'Callaghan well on his retirement. All those who attended are most grateful to Ian Yule, Lecturer, and Marion Turner, Faculty Secretary, who planned and effectively organised a most interesting programme.



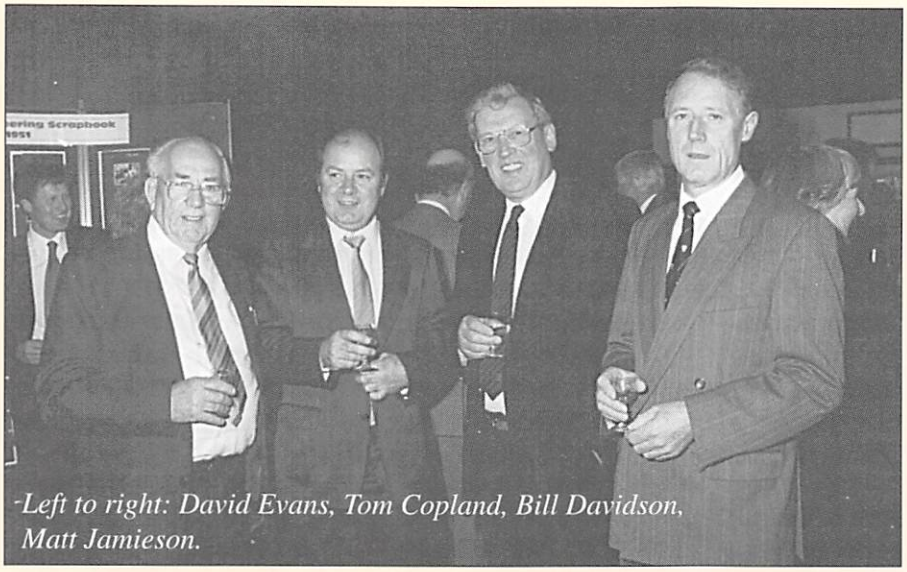
Left to right: Derek Greig, Alfred Gracey, Tony Trapp, Graham Sibley.

It may be of interest to mention that the first intake of students to the Agricultural Engineering Department, then King's College, University of Durham, was in October, 1947. This was the first university degree in agricultural engineering in the UK. Prof. E McEwen was the founder professor. The degree offered was a two year MSc degree of taught courses, with a thesis as part of the requirement for the final year. The basic idea was to offer a degree in agricultural engineering to either engineering graduates by providing courses which would give a basic understanding of agriculture, or to agricultural graduates by providing engineering courses. Needless to say, there has always been considerable discussion as to the merits of this concept and as to whether the best starting point was agriculture or engineering; over the years, however, many of either initial discipline have made significant contributions to agricultural engineering. In the 1950's, a number of PhD candidates joined the Department and they contributed significantly to a knowledge of soil dynamics and, to a lesser extent, to other topics, such as grain drying. By 1966, undergraduate studies in both agricultural engineering and farm mechanisation, as well as an extensive postgraduate programme, was being undertaken. In 1987, the Agricultural Engineering Department was merged with the Department of Agricultural and Environmental Science. Agricultural engineering courses are still being offered but the number of staff and students is much reduced, matching trends at other educational establishments.

The reunion programme included a barbeque on Friday evening, 22 September, at Nafferton Farm, a dinner in the Student Union on Saturday evening and a visit to Soil Machine Dynamics Ltd on Sunday morning. There was a very encouraging response from past graduates to the reunion, though mostly from MSc graduates from 1950 to 1966. Many who were unable to attend sent best wishes.

Seventy-two persons attended a very pleasant evening and an excellent barbeque in the Agric. Engng Building, Nafferton Farm, on the Friday evening. They were entertained with displays of folk dancing and Northumbrian piping. Many of those attending must have remembered a more basic and unheated winter interior when they laboured with uncertainty, with foreboding, and with obscure and perhaps unsatisfactory bits and pieces to provide data so that their MSc theses would have some apparent credibility.

The high point of the reunion was the dinner on Saturday evening, with eighty-two in attendance. It was a much grander meal than many of us had once been accustomed to in the Bun Room or the Barn. Alan Reece, a faculty member of the Agricultural Engineering Department for thirty years and then founder - now Managing Director - of Soil Machine Dynamics Ltd, a world force in sub-sea trenching, gave the after dinner speech. Alan was well known to most of those



Left to right: David Evans, Tom Copland, Bill Davidson, Matt Jamieson.

present for his enthusiasm, sound and extensive knowledge, communication skills and humour in the lecture room and in the laboratory. Many had also been with him on a mountain side or a rock face where he always appreciated good weather and views, but he probably even more enjoyed the discomfort of his companions when the weather was appalling and the visibility next to nil.

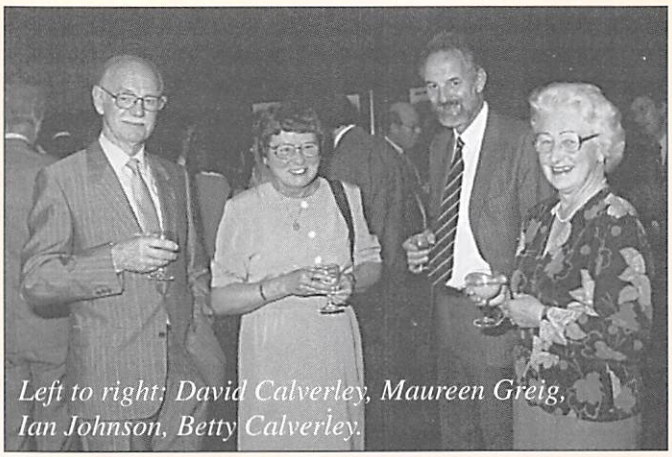
Alan's speech was typically 'Reece', in parts very serious and thought provoking but well spiced with anecdotes which for either legal or decency reasons cannot be recorded here. Alan felt that the Department had been so successful because there had been a clear concept of an engineer as a 'man of action' who could get things done to make the world a better place through an understanding of the physical laws such as those of Newton and Bernoulli. He further attributed the success of the Department to the staff, a high proportion of whom were very clever, but all of whom were extremely industrious, and were friendly and approachable. Another factor which he felt contributed was that many of the students were farmers' sons, with experience of farming operations which were seasonally dependent. This gave them a sense of urgency which was apparent in their student and subsequent professional activities.

Professor Jim O'Callaghan thanked Alan on behalf of all those present for a thought provoking and entertaining talk. He was grateful to all those present who had wished him well on his retirement. While he was gratified by the success of agricultural engineering at Newcastle over the past fifty years, he stressed the need to look ahead. He drew attention to the recent International Conference, 'Agricultural and Biological Engineering - New Horizons and New Challenges'. He felt that the future was very challenging and presented many new and exciting areas, requiring unique combinations of engineering technology and biological science.

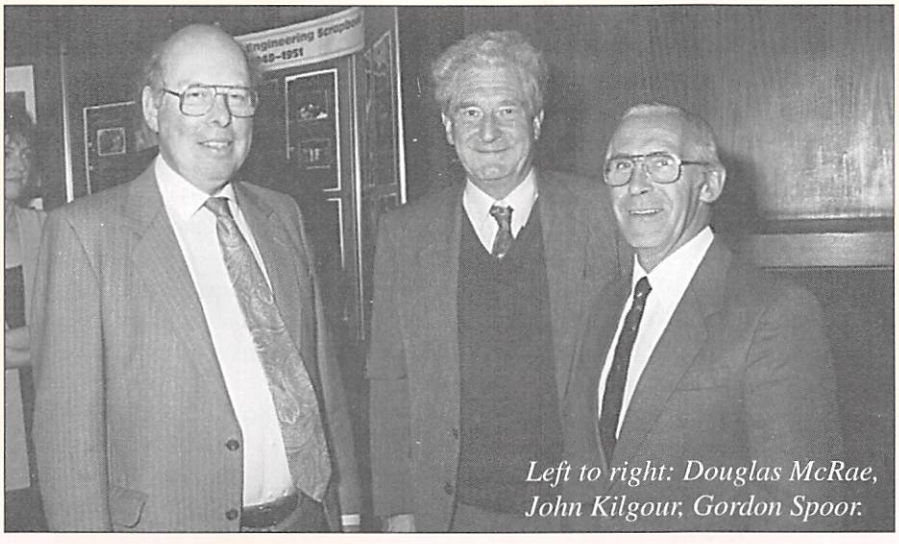
On Sunday morning at the invitation of the Directors, there was a visit to the design and manufacturing centre of Soil Machine Dynamics Ltd, Wincomblee Road. The company won the 1994 MacRoberts Award for Innovation in Engineering (see *Land Technology, Autumn 1995*).

The visitors were impressed by the magnitude and level of the technology for the design and construction of underwater ploughing systems for seabed operations. Visitors saw examples of very large scale ploughs used for burying pipes and cables; underwater, remotely controlled vehicles; deck equipment for handling ploughs on and off ships; and the control systems for the ploughs and associated equipment. Those who had known something of the initial work in small soil tanks with rudimentary equipment and instrumentation in the Department of Agricultural Engineering were perhaps in a unique position to appreciate the transformation of what was considered mildly interesting academic research into major commercial engineering in less than a decade. All those present wish to thank Alan and his staff for a most informative tour and an excellent lunch.

DSB



Left to right: David Calverley, Maureen Greig, Ian Johnson, Betty Calverley.



Left to right: Douglas McRae, John Kilgour, Gordon Spoor.

New Zealand no-tillage research centre

A research centre, believed to be one of the very few in the world which is dedicated solely to no-tillage (direct drilling), has been created in New Zealand. **Dr C John Baker**, FIAgrE, is the Director of the Centre for International No-tillage Research and Engineering (CINTRE) which is staffed by scientists and engineers who previously created the unique *Cross Slot*™ no-tillage technologies at Massey University. That university has now sold all of its interests in the technologies to *Cross Slot Technology Ltd* of Auckland, New Zealand. Funding for the centre is partly provided by the university, and partly by government and independent sources.

A major part of the centre's function will be to push further the boundaries of no-tillage as a truly sustainable food production technique using the centre's own *Cross Slot*™ products. The centre will also facilitate cooperative research programmes on no-tillage with other research organisations around the world. The objectives include developing new and innovative farm management and production techniques not hitherto thought possible with conventional no-tillage technologies, and exploring the role of low risk no-tillage in difficult soils and agricultural economies, as well as in mainstream industrialised agriculture. The address for CINTRE is: Nannestad Line, RD 5, Feilding, New Zealand *(and don't criticise the Editor for the spelling of either the acronym or the city).*

Nomination review

The Institution recently underwent a Nomination Review by the Engineering Council. These reviews take place every five years and are intended to ensure that Institutions are being run in a way which meets The Engineering Council's standards. The reviews look carefully at many aspects of the Institution's activities (including its financial stability), and place particular emphasis on the quality standards governing admission to membership and registration of members with The Engineering Council.

The Secretary, Michael Hurst, is pleased to report that the Review has resulted in the *Institution's re-nomination for a further five years.* Registration at IEng and Eng Tech level will continue to be handled by the Institution on behalf of The Engineering Council. Registration at CEng level will continue, as before, under an affiliation agreement with the Institution of Civil Engineers. Members can be assured that the Institution continues to meet the standards expected of it by The Engineering Council.

Members' Handbook & Buyers' Guide, and the Members' Register

By now, members should have received their Handbook and Members' Register. The Handbook contains the Green Book product and manufacturer listing compiled by one of members, Harry Catling, and is intended to help people in their work. The Handbook also contains information about the Institution and other organisations.

The Members' Register lists members contact addresses and telephone numbers. It is meant as an aid to networking among members, and if there are any errors, omissions or suggestions, please contact the Secretariat.

Both publications have been produced by the McMillan Group plc, to whom we offer our thanks. The funding has come from advertising in the Handbook and from sales of the Handbook (but not the Members' Register) to non-members.

Michael Hurst, Secretary

Information Update 1995

This year we will again be sending out our Information Update, so that we can keep our records up to date. It is also a way of members informing us if they wish to change their Specialist Group, pay by direct debit, take out a deed of covenant or register with particular Special Interest Groups of EurAgEng.

The Information Update forms has been sent to each member with the membership renewal document in December. Please complete the form and return it to the Secretariat as soon as you can.

Michael Hurst, Secretary

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Testing cubicle mats for dairy cows

John Dumelow

Introduction

For a cubicle building to be effective, the cubicles must have high rates of occupation. However, they are often rejected by animals which instead choose to sleep in the unbedded and dung soaked passages. It has been shown that the type of bedding provided in the cubicles affects their rates of occupation. Cattle prefer a soft lying surface, the preferred choice being sawdust of approximately 15 cm thickness (Nilsson, 1988; Irps, 1993; Wander and Fricke, 1974).

However, the use of loose bedding, such as sawdust or straw, results in additional labour and material costs to the farmer. Often no bedding is provided, resulting in increased injury, high cubicle rejection rates and reduced welfare. An increasingly popular alternative is to use synthetic mats to cover the concrete lying area. The range of such products is extremely diverse and there is little scientific evidence available to allow optimum designs to be identified or developed. ADAS has been conducting a programme of work to bridge this knowledge gap. A method of mechanical testing was developed and used to evaluate a range of materials.

This report describes the required properties of cubicle mats, based upon current knowledge, outlines the testing procedures undertaken to quantify these properties, gives the results of these tests for various types of mat and hence identifies those types that are most suitable.

ADAS, Coley Park, Reading Berkshire RG1 6DE

1. Mat properties

There are many properties that define the effectiveness of cubicle mats. However the two main factors are hardness and durability. These are discussed in more detail below.

1.1 Hardness

Forces applied by dairy cows to the floor during standing and lying have been investigated by Metzner (1978), who found that maximum loads of around two thirds of the body weight are applied through the front knees when in the position shown in *Figure 1*.

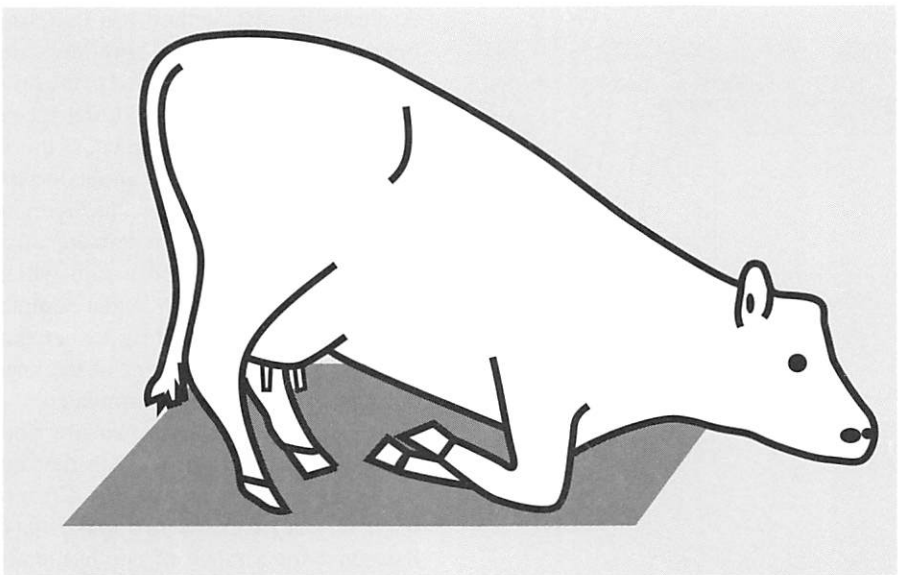

Fig. 1 Position of cow at which maximum load occurs on knees during lying (Metzner, 1978).

Measurements show that the contact area between the bent front knee of a dairy cow and a solid surface is approximately 15 cm^2. For an animal weighing around 600 kg, the maximum applied load to the knees will be around 4 kN. Assuming this load is distributed equally through each knee, the mean contact pressure between each knee and a smooth solid surface will be around 1.3 MN/m^2. Any surface irregularities will lead to much higher pressures, causing considerable discomfort and even greater risk of injury. Pressures on the knees can be reduced by providing a soft lying surface, so that the knee sinks into the flooring material providing a larger contact area. Soft lying surfaces also damp the impact of the knee as it is lowered onto the floor. Because of these high pressures acting on the knee, mat hardness is thought to be the most important factor determining suitability for cattle.

However, knee injuries are not the only problem. The cow will also spend much time standing on the mat and flooring requirements of the cow when standing are thought to be different from those when lying. Under the cow's body curve

weight, its hoofs will sink into the mat, and it has been postulated that the animal will only feel steady if full mat deflection occurs under its body weight (Lasson and Boxberger, 1976). It was suggested that if this does not occur, slight movement by the cow will cause the hoofs to sink further into the mat, making her feel unstable. In order to compensate for this, the cow may angle her hoofs so that they sink further down into the mat, providing a more stable foothold. This results in an unnatural standing position that puts strain on the leg joints and ligaments, predisposing the animal to lameness.

Consequently, a compromise is required so that the mat is both sufficiently soft to cushion the knee and sufficiently hard to support the hoof firmly.

Hardness is usually quantified by measuring the penetration of a steel sphere into the test surface. The standard measurement of hardness, the "Shore" test, is performed in this way using small test spheres, of less than 10 mm diameter. When measuring the hardness of cattle mats, however, such small diameter spheres are not appropriate, as sufficient mat penetration cannot be achieved. Instead, researchers have used larger spheres of up to 240 mm diameter.

Maximum and minimum acceptable force/penetration curves are a good way of describing the required hardness, and such curves have been suggested for cattle mats by Nilsson (1988) based upon the requirements outlined above. His recommendations are based on penetration tests using a sphere of 100 mm diameter which he suggested approximates to the dimensions of a cow's knee. In order to confirm this, ADAS measured bent knees of 25 dairy cows using a profile gauge. It was found that the knee profile, in both front and side elevations, could be approximated to an arc. The average arc radius was 60.87 mm and therefore it was concluded that the most suitable sphere diameter for hardness testing of this type is approximately 120 mm.

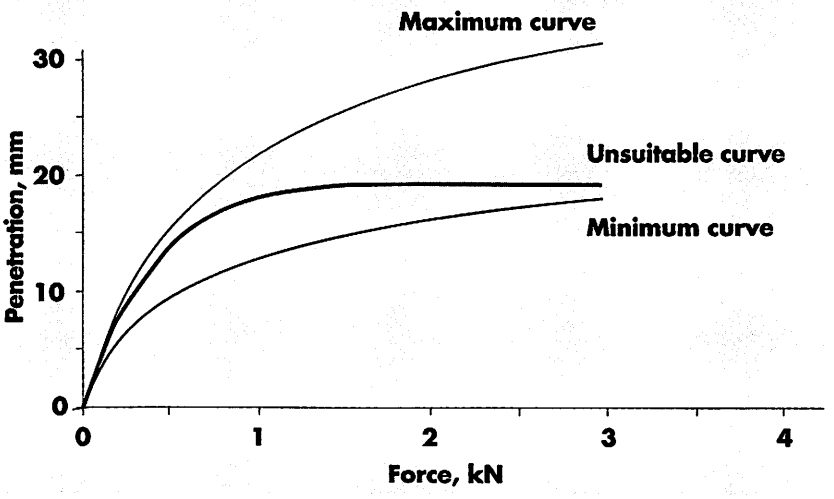

Fig. 2 Recommended maximum and minimum force/penetration curves for cattle mats (Nilsson, 1988), adapted for test diameter of 120mm. Note that an unsuitable response curve may occur within the recommended band.

Nilsson's recommendations have been interpreted for a 120 mm sphere and are shown in *Figure 2*. He recommended that the force/deflection curve for a suitable mat should lie between the two curves shown.

An important requirement of the mat is that, under a fully loaded knee (2-3 kN), it should still be sufficiently soft to allow further penetration with increased load, preventing sudden increases in contact pressure. This means that the force/deflection curve should have a sufficiently steep gradient within this load range. This is reflected in Nilsson's curves which both have positive gradients between 2 and 3 kN. It is possible, however, for a curve to fall between Nilsson's curves whilst being unsuitable, if the curve has a very small gradient over the critical load range *(Figure 2)*.

1.2 Durability

Hardness is probably the most important factor determining the suitability of cubicle mats. However, the hardness of a mat is likely to change considerably with use, so a method of assessing the change in hardness, i.e. the durability, is required.

A durability test method has therefore been developed which simulates the dynamic force system applied to the floor by the front knee of an adult dairy cow while getting up or lying down, as this is when maximum loads are applied to the floor. This test rig is shown in *Figure 3*, and consists of a 120 mm diameter steel hemisphere mounted on a ram which repeatedly impacts with a mat sample. The geometry of this test rig is such that both the forces and motions of the knee during standing/lying are simulated.

This test rig is used to measure both hardness and durability. With the ram stationary, penetration of the 120 mm diameter steel hemisphere into the mat is measured for a range of applied loads, before any ram impacts have occurred (this produces the initial force/penetration

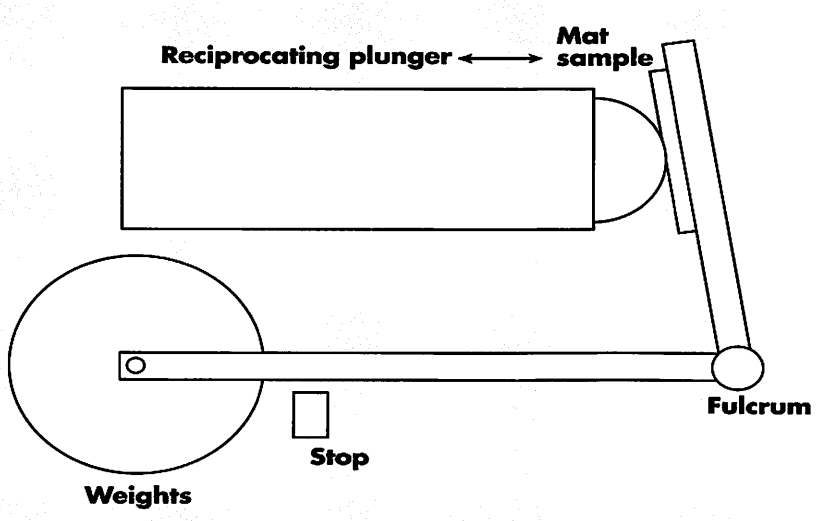

Fig. 3 The combined hardness and durability test rig.

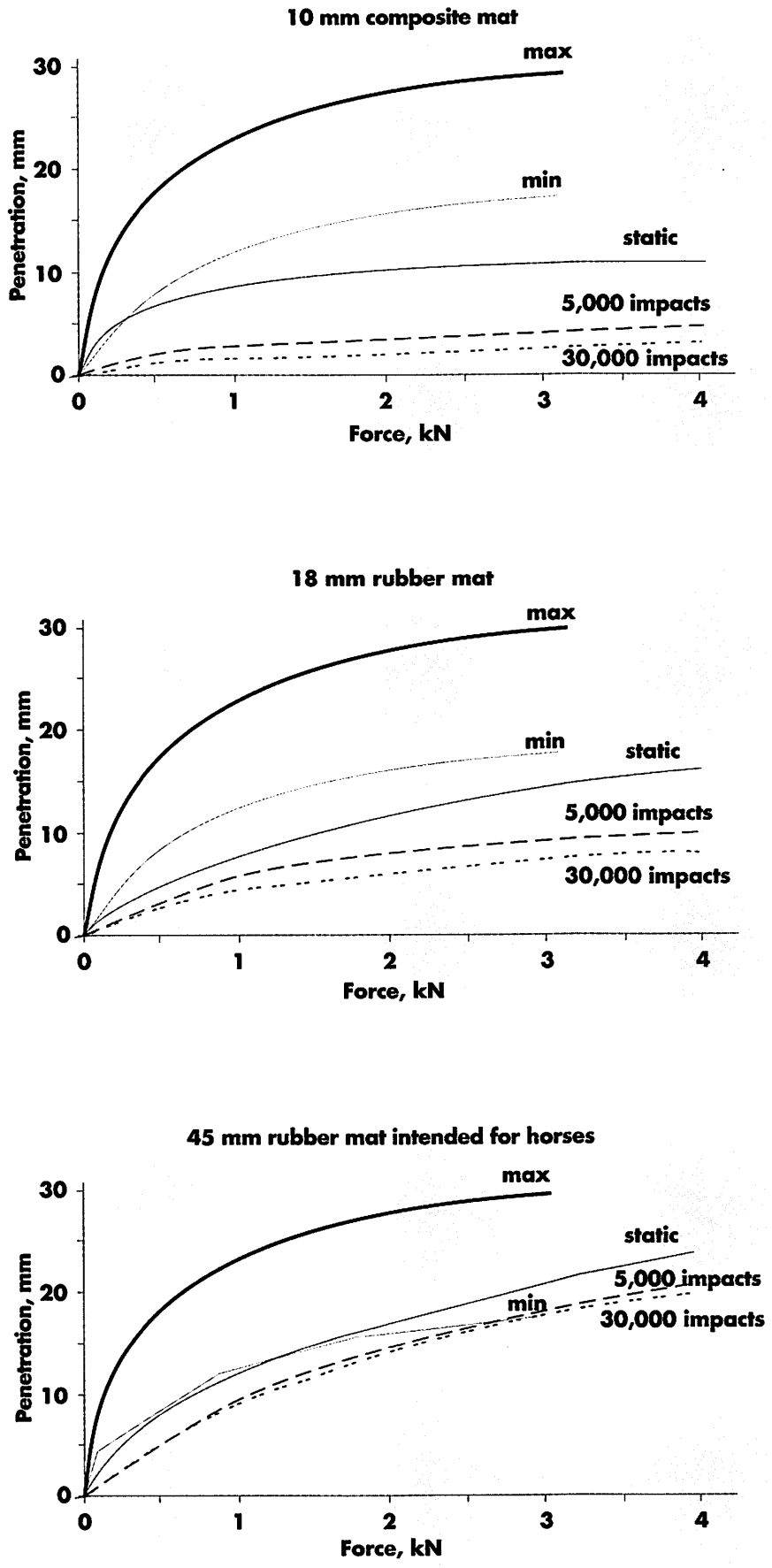

Fig. 4 Force/deflection curves for a range of typical materials tested on the hardness/durability test rig, together with maximum and minimum recommended responses.

for the material under test as discussed in Section 1.1 above) and subsequently every 5,000 impacts up to a maximum of 30,000. This is equivalent to 4 impacts per day over a period of 20 years. Durability is then quantified as the change in hardness over the test period. Eight proprietary materials ranging in thickness between 10mm and 45mm were tested on the rig. Except where otherwise indicated in the list below, all these materials are marketed for use in dairy cow cubicles:

10 mm composite mat,
10 mm rubber screed applied direct to floor surface,
18 mm hard rubber mat,
18 mm rubber mat,
20 mm composite mat,
20 mm rubber mat intended for horses,
22 mm rubber mat,
45 mm rubber mat intended for horses.

2. Results and Discussion

2.1 Hardness/durability tests

The force/deflection curves for three of the materials tested are given in *Figure 4*. As the tests proceeded, some of the materials became considerably permanently compressed, resulting in a substantial reduction in thickness (*Figure 5*). Consequently, the penetration under load was also substantially reduced and, in effect, there was a considerable increase in hardness. This effect was particularly severe with the composite mats. It can be seen that the performance of the thickest (45mm) material is closest to the recommendations and even for this material the deformation under load is rather low. All other materials tested were too hard. The fact that the this material performed best is not a coincidence. *Figure 7* shows that there is a direct relationship between thickness and penetration, i.e. hardness. Clearly, thicker materials can deform more, resulting in greater cow comfort. There appears to be no technical reason why some of the other mats tested could not be made thicker in order to allow increased penetration. Provided that they do not suffer excessive permanent deformation with use, they should prove highly satisfactory.

2.2 Other properties

In addition to hardness and durability the following properties may also have an effect.

appropriate hardness characteristics are

(a) Slip-resistance

As the cow manoeuvres within the confines of her cubicle, any slips are likely to result in impact with either the cubicle partitions or front wall, which could result in severe injury. The flooring surface within the cubicle should be sufficiently slip-resistant to avoid such injury. In a recent review, McKee and Dumelow (1995) suggest that the most accurate method of determining the slip-resistance of livestock floors is to use a test method that replicates the hoof/floor interaction. Such a test method has been developed for cattle by Dumelow (1993). Although this was developed for evaluation of non-slip concrete finishes for cattle buildings, it could be used to measure the slip-resistance of cubicle mats. The author is aware of instances where rubber mats have become extremely slippery, but this arose when the mats were wet and dung covered. However, as cubicle floors are normally kept relatively clean and dry, slipperiness is not thought to be a problem in this application.

(b) Abrasion

An excessively abrasive surface will cause injury to the knee during standing and lying. Such erosive injury is not considered to be a major problem with cubicle mats, which are thought to be less abrasive than concrete. As a result, no specialised test method has been developed to quantify the abrasiveness of cubicle floors, although such a technique could be developed by fitting an easily worn material, such as plaster blocks or pencil erasers, onto the durability test rig. Abrasiveness could then be quantified as the weight loss of this material over a test period.

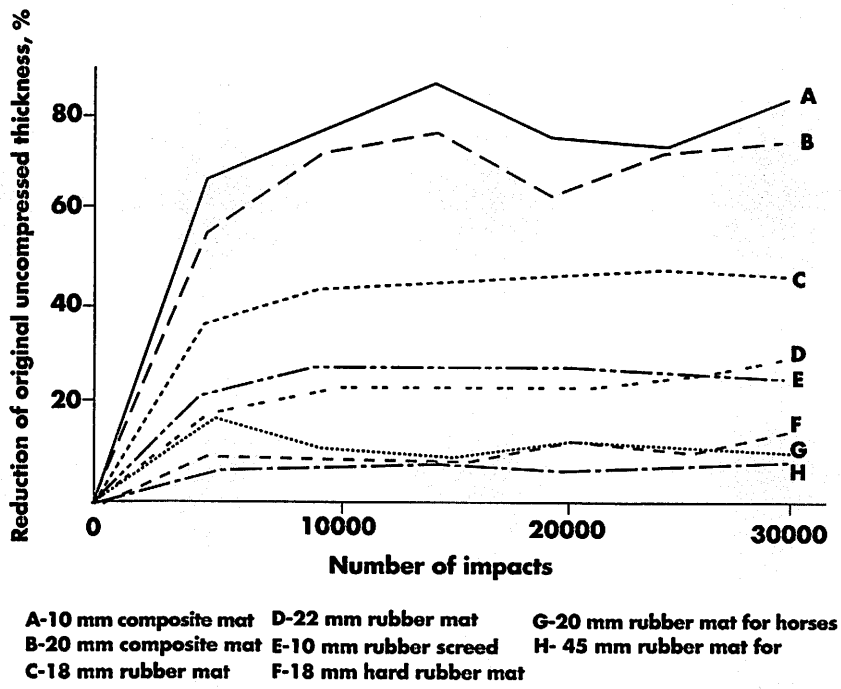

Fig. 5 Effect of number of impacts on percentage reduction in thickness.

c) Hygiene

Mastitis is a considerable problem in dairy cattle and is a result of bacterial infection. The extent to which cubicle mats permit the growth of harmful bacteria is therefore of major importance. Hygiene of various generic mat types could be investigated by installing them in a cubicle house for a test period, after which test samples would be cut from them for microbiological examination in the laboratory. Alternatively, a small amount of bedding could be applied to each mat and samples taken at intervals for analysis. From these results, the hygienic suitability of the various mat types could be evaluated.

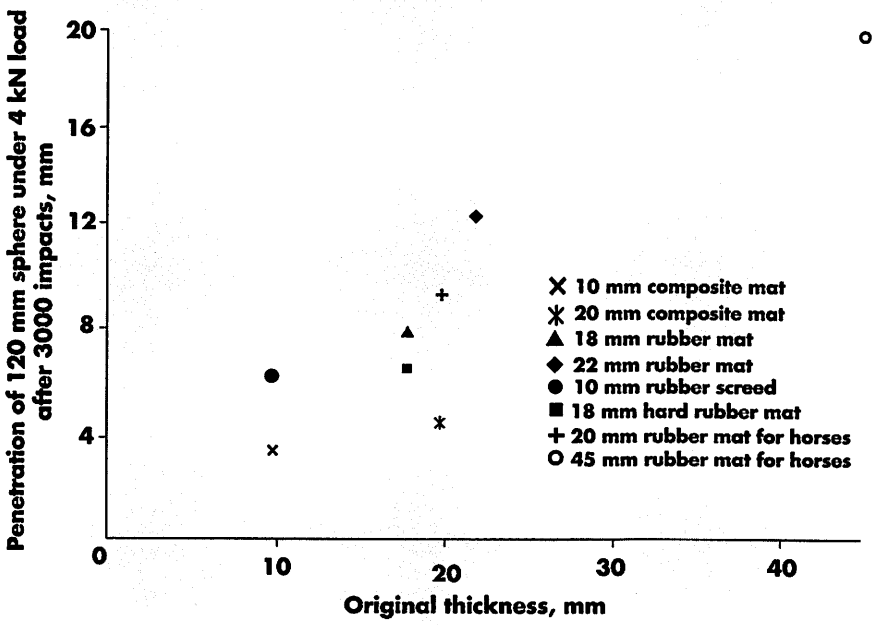

Fig. 6 Effect of original mat thickness on hardness after 30000 impacts.

(d) Thermal properties

According to Wander (1974), the thermal properties of a cubicle mat are of minimal importance in a temperate climate. Nilsson (1988) also suggests that if a floor has appropriate hardness characteristics, as described in Section 1.1 above, then the floor will also have suitable thermal characteristics.

3. Conclusions

It is thought that hardness is the most important characteristic determining the suitability of synthetic mats for dairy cattle. Hardness requirements are twofold. Firstly, a mat should allow the knee to sink into the mat sufficiently to prevent excessive contact pressures. Secondly, the mat should be sufficiently hard to support the hoof firmly. Mats should also be designed to ensure that

maintained with use, i.e. the mat should be durable. Test methods for both hardness requirements and durability were developed, and the results indicate that most materials are too hard. None of the materials tested were excessively soft. In general the thicker materials performed better and, of the mats tested, the thickest (45mm) performed best.

These experimental findings are based entirely on laboratory experiments using the hardness/durability test rig. It would be highly desirable to verify these findings with live cow preference tests and it is hoped to undertake these tests in the near future. Tests on the hygiene of mats should also be carried out.

Acknowledgements

Financial support for this work from the (UK) Ministry of Agriculture, Fisheries and Food (MAFF) is gratefully acknowledged. The author is also grateful to Callum McKee, David Powell and Peter Fearn who carried out most of the work described in this paper.

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Book Reviews

Tractors at Work (A Pictorial Review 1904-1994)

by Stuart Gibbered
Published by: Farming Press
ISBN 0 85236 284 6
Price: £14.95

This, as the title suggests, is a pictorial review chronicling the changing scene of working tractors over the last ninety years. Indeed, there are some 167 separate photographs selected by the author, not only to illustrate change but also to emphasise the variety of practical uses to which the tractor has been put during this century.

The book is very well presented in hard back and even the earliest photos from 1904 are very well reproduced. It has only a limited index but this is in keeping with the rest of the work. It is intended as a book which you "flick" through, rather like a magazine of interest, rather than following a precise story. It is, of course, more or less in chronological order allowing the reader to follow a "potted" history. The author, however, has broken with this order whenever it seems to suit his needs. This rather adds to the charm of the piece, and I am sure that it will appeal to those with an interest in farm machinery history.

Indeed, many of the photographs will give great pleasure as they are rare and depict tractors long lost in the annals. As regards my recommendation: if you are an old tractor buff, buy it; if you like rural working photos, I am sure that it will appeal.

MJH

An Introduction to Wastes Management

Second Edition, 1995, *by Jane Barron*
Published by: The Chartered Institution of Water and Environmental Management
ISBN 1 870752 21 X
Price: £7.50

This introductory booklet on wastes management is the first of a series to be published by CIWEM on an aspect of environmental management which is today giving rise to increasing concern. It confesses to be an "introduction to the subject" and a "general guide to the interested lay-person". In fact, it is much more than that. The well written and presented text gives balanced summaries of the reasons why we must manage wastes properly, the evaluation of the legal framework and how it might ensure acceptable management. It discusses the types of wastes produced and the methods available for their recovery, transport, treatment and disposal.

The work is also packed with other useful data, including costing, planning, a comprehensive glossary, and bibliography. I have found it an excellent reference work for anyone wishing to understand more about wastes management.

MJH

Early Years on the Tractor Seat

by Arthur Battelle
Published by: Farming Press
ISBN 0 85236 276 5
Price: £4.95 (paperback)

As the title suggests, this is an autobiography covering the period 1938, when the author left school, up until his marriage in 1948. During this time, he progressed from working in a garage, to working on farms and on threshing rigs. He became a contractor and spends much of the book relating encounters with various tractors.

In essence, the book is a series of incidents, often humorous, interspaced with mechanical problems encountered and solved in sometimes very novel ways.

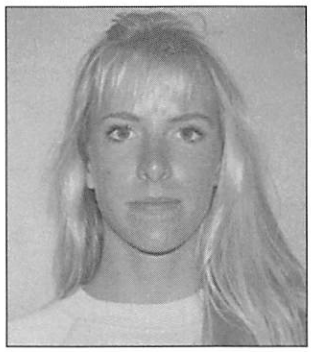
What is offered the reader, therefore, is an insight into farm machinery contracting in war time conditions; hardly a crafted history, more a series of good yarns set in the period. I am sure that its main attraction, however, will be for anyone with a flair for "taking things to pieces" just to see if they work; perhaps even more for solving the endless "little problems" that seem to beset all machines of that or any other period.

It is, of course, a light work intended to entertain and inform just a little, and that I feel it does very well. For machine fanatics this, I am sure, they would happily put on their Christmas or birthday lists.

MJH

Erosion of forest roads

Richard C Johnson and Rachel K Bronsdon



Abstract

Two experimental forest road sections were studied to determine the processes of erosion and sediment transport from these types of roads. The runoff from unused, compacted roads was greatest but the sediment load from a used road was twice that of the unused road and the load from a used road following regrading five times that of a unused road. This agrees with results from other studies in the USA, New Zealand and Australia. The sediment removed from the forest roads was very fine, with 75-85% being less than or equal to 355 µm. The erosion process associated with heavy use of the roads starts with the development of wheel ruts and the erosion of fine material. The management technique of regrading removes the ruts but fine sediment is made available for some eight months following regrading until the fine sediment is washed-out and a protective, coarser layer is developed on the road surface.

1. Introduction

Increased sediment loads in rivers draining forested catchments have been reported by a number of UK authors such as Robinson and Blyth; 1982, Leeks and Roberts, 1987; Kirby et al, 1991; Moffat, 1988; Soutar, 1989 and Johnson, 1993. These studies included a range of forestry management practices from hillslope cultivation to clearfelling and the results from such studies have contributed to the development of management practices such as the Forests and Water Guidelines (Forestry Commission, 1993). In one study, at Balquhidder in the southern Highlands of Scotland, Johnson (1993) suggested that an observed eight fold increase in catchment sediment yield was closely associated with the increased use, and erosion, of the forest roads for timber extraction. In the only previous study (Duck, 1985) in the UK on these types of roads, a 20 fold increase in the sediment load of a burn was reported following road construction.

In the UK, there are 16,000 km of roads within Forestry Commission plantations, 9,000 km of which are timber haulage roads (Hay, 1986). In the late 1980s, many forests in the UK were reaching maturity so clearfelling, and the use of these forest roads for timber extraction, was increasing. Previous studies, carried out in other countries, have monitored erosion from a range of different road types and a number of erosion mitigation techniques have been suggested. Results also indicated that careful design and management of roads can minimise downstream water quality degradation and help preserve sensitive instream environments. The position in the UK was unclear and, in 1991, the National Rivers Authority commissioned the Institute of Hydrology to carry out a study into the erosion of forest roads. The primary objective of the project was to identify and assess the natural processes inherent in the erosion of mixed aggregate, unsurfaced roads in upland forests, and to quantify sediment production from these unsealed roads and its relationship to road use by heavy timber extraction vehicles. This paper summarises the results from one part of the study where the erosion processes on two road sections were monitored.

2. Literature Review

A literature review of previous studies into the erosion of forest roads revealed that most work has been carried out in the USA, Australia and New Zealand; little previous research has been reported from the UK.

Some of the earliest work on forest road erosion was carried out in the Coweeta catchments, USA, where studies initially concentrated on roadbank stabilisation, using natural protection measures, and timber extraction, using techniques such as haulage by horses. Erosion rates of 408 m^3/km were found, with most of this material entering the streams (Swift, 1984). In the early 1960s, the 'broad-based dip' was designed and demonstrated at Coweeta. This was described as a gentle roll in the centre-line profile of the road, so that a downslope reverse gradient of 3% for over 6 m was constructed to block any water flowing down the road. The dip was sloped outwards to drain water off the road and onto the forest floor where it would be intercepted and dispersed by forest litter. Other recommendations from the Coweeta study included the careful design of culvert size, use of gravel surfaces, grassing surfaces when the road is only lightly used, no inside drainage ditch and no vertical roadside banks. A number of other physical characteristics of the roads have been considered as significant in the erosion and transport processes: Trimble and Weitzman (1953) included gradient,

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length of road, intensity of use, soil, vegetation and climate; while Haupt (1959) included cross ditch interval, road gradient, embankment slope length and slope obstruction.

Fahey and Coker (1989) reported on a forest road erosion study where runoff from four road sections was channelled into collection drums, the first being a primary settling tank for large particles and the second a settling tank for fine material. A V-notch was located on the side of the second tank with water levels recorded. The drums were emptied monthly, the sediment weighed and the particle size analysed. Results from the plots showed that average annual sediment yields were in the range 1.6 to 11 kg/m^2 for the road surface and drainage ditch combination.

Erosion caused by vehicle use has been studied, with Reid and Dunne (1984) showing that a forest road produced 7.5 times more sediment when it was heavily used compared to when it was not used. Haydon (1991) compared the sediment produced by two roads, one a control with low use and low maintenance and the other subjected to a series of combinations of use and maintenance. The main conclusions were that the annual sediment production from a typical forest road was 30 t/ha and the sediment yield was greatest in high use/low maintenance situations (35 - 40 g/*l*) compared to high use/high maintenance or low use/low maintenance situations (23 g/*l*).

A major study was carried out in the USA into the reduction of erosion from forest roads (Burroughs and King, 1989). Results showed that logging traffic increased the sediment production by a factor of two relative to a smooth, unsurfaced road. This could be decreased by the use of a gravel surface which reduced the sediment production by some 80%. Burroughs and King concluded that successful control of erosion by "gravelling" is dependent upon the erodibility of both the gravel and the underlying material, and suggested that reductions in sediment yields can be maximised by applying a gravel layer consisting of hard crushed rock over those roads constructed of easily erodible material. Swift (1984) looked at the merits of different thicknesses of gravel layers and found that the addition of a 5 cm gravel layer produced no notable decline in sediment yield, and was quick to deteriorate, but the addition of a 15 cm and a 20 cm layer gave sediment reductions of 90% and 96%, respectively. Burroughs and King also measured sediment yields on sections of an unsurfaced road, and on two road segments surfaced with dust oil and bituminous surface treatment. The treated surfaces had reduced sediment yields of 68% (dust oil) and 96.5% (bituminous), but dust oil was shown to release volatile chemicals into surface runoff and to breakdown easily under heavy traffic, and bituminous treatment is costly.

Studies on road embankments and cuttings have shown high rates of erosion immediately after construction. Mitigation measures show increasing effectiveness as the percentage ground protection increased, and show decreasing effectiveness with increasing gradient and siltiness of the soil. Barriers to surface flow consisting of logging slash showed a 75 to 87% reduction in sediment yield, compared to adjacent slopes (Cook and King, 1983; Rothwell, 1983). Effective measures for erosion reduction on cutslopes include using dry seeding which can substantially reduce sediment yields once germination has been achieved. The success of this method, however, is dependent upon slope gradient. For roadside drains, the most successful method of reducing erosion is the use of a rock blanket, or riprap. The size of material used in the riprap can be calculated by using information on the channel dimensions and the expected peak flows in the drain (Furniss et al, 1991). Finally, an experiment was carried out by Burroughs and King (1989) using simulated rainfall on roads with different combinations of pro-

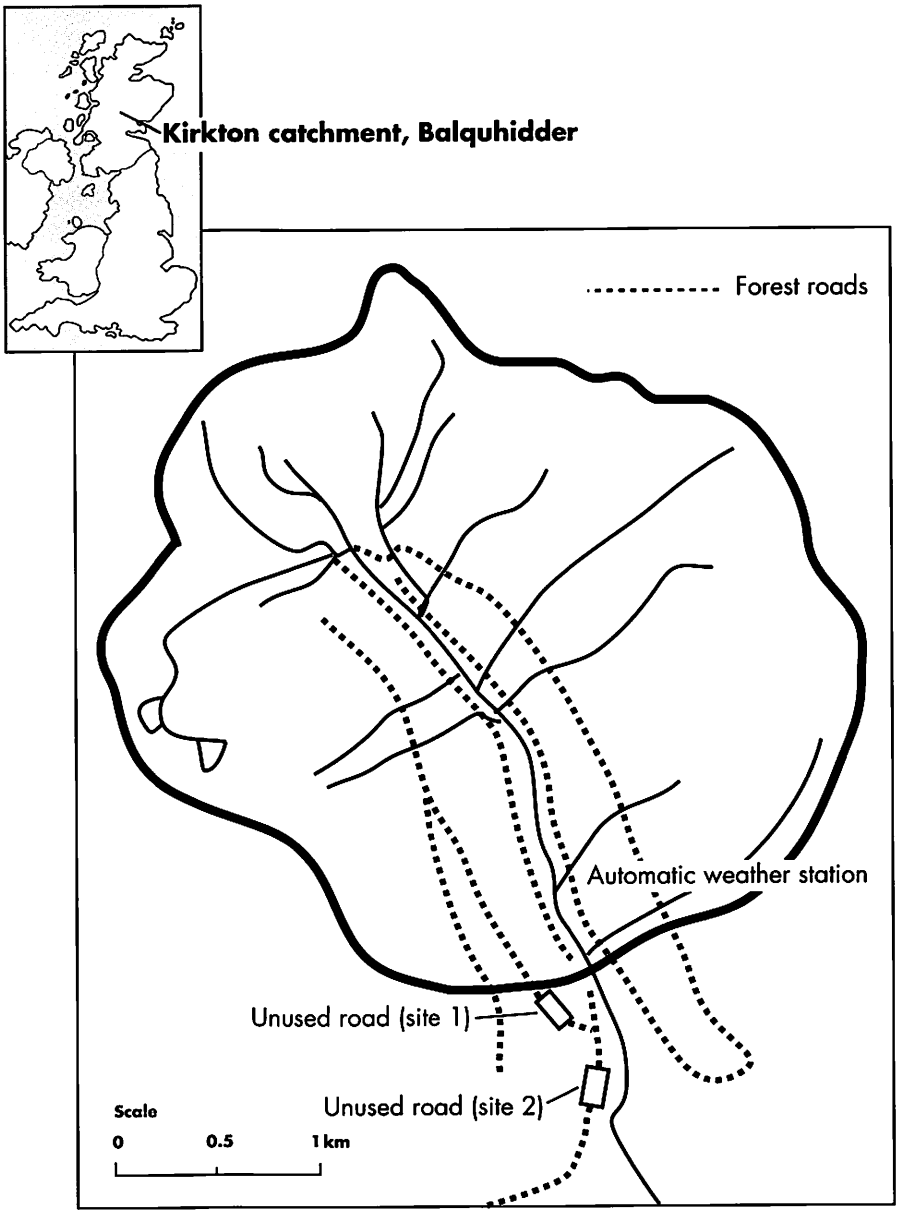

Fig. 1 Instrument sites in the Kirkton catchment, Balquhidder.

tection. They showed that the sediment yield from the whole road decreased as protection measures were applied: the addition of gravel to a road surface reduced the yield by an average 33%; road protection plus riprap of the roadside drain 57% and road protection, riprap of drains plus protection of embankments 91%.

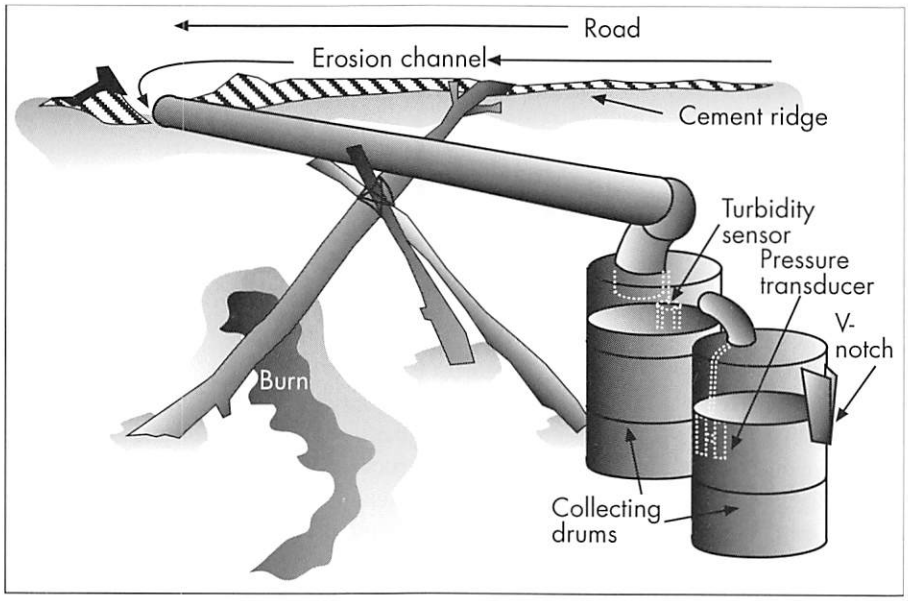

Fig. 2 Forest road instrumentation.

3. Forest Road Experimental Site

Two forest road experimental sites were established in the Kirkton catchment, Balquhidder, Central Scotland *(Figure 1)* to study the processes of erosion and transport of sediments. The catchment area is 6.85 km^2, of which 40% had been afforested some 50 years previously. Within the forested area, 10 km of forest roads had been constructed at the time of planting using locally derived material. Up to 1985, the roads were only lightly used and had become highly compacted; then, in late 1985, road upgrading was carried out in preparation for clearfelling of the forest and timber extraction by articulated logging lorries. In 1991, two road sections were identified for monitoring: one section which had not been used by the logging lorries for some three years (site 1) and one road section on the main forest road into the catchment which had been heavily used for the previous six years (site 2) *(Figure 1)*.

The experimental sites were designed to carry out continuous measurements of rainfall, surface runoff and sediment loads and to collect information on vehicle use *(Figure 2)*. The most successful method of isolating the road sections, while still allowing vehicles to pass, was to use concrete humps across the road with the surface water channelled into a 125 mm pipe and down into two collecting drums. The sections were surveyed to determine the area of road contribution to the runoff. To measure the discharge of water from the drums, a V-notch was welded into the side of the second drum and water depths logged automatically using a pressure sensor. Sediment discharge was recorded using a turbidity sensor in the first barrel and also by manually recording the amount cleared from the drums each month. Sub-amples of sediment from the two collecting barrels were dried, weighed and sieved. Rainfall was recorded automatically at the site and other climatic data were available from an automatic weather station located some 300 m away. Data from the turbidity sensor, pressure transducer and a tipping bucket raingauge were recorded at 10 minute intervals on a Campbell logger.

Calibration of the turbidity sensor was achieved by taking manual samples of water from around the sensor in a range of conditions and noting the turbidity values recorded on the logger. A regression equation was generated relating the turbidity values to the suspended sediment concentrations in mg/*l*. Conversion of data from the pressure transducer to discharge in *l*/s was achieved through calibration of the V-notch on the side of the second settling drum.

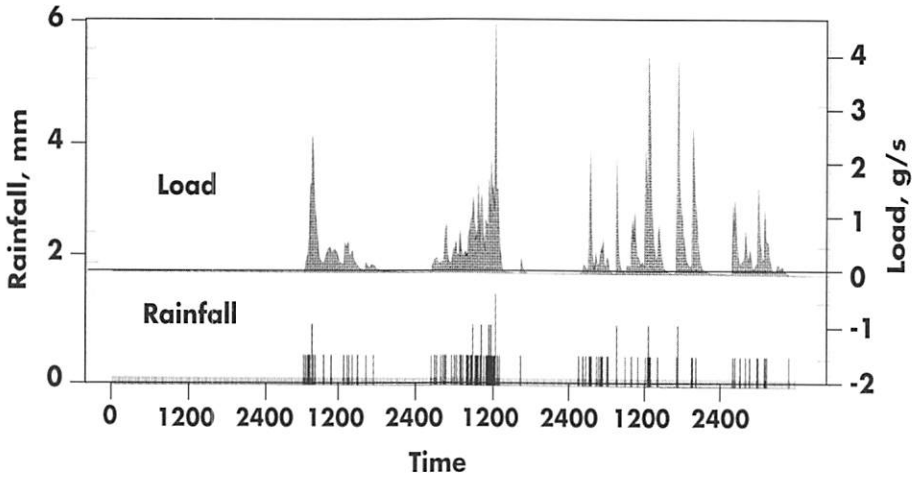

Fig. 3 Example of rainfall and sediment load values for the period 11-15 November 1994.

4. Results

Data collection started on the unused forest road (site 1) and continued for some eight months before the instrumentation was moved to the used forest road (site 2). After some three months, the used road was regraded by the Forestry Commission and data were collected for a further eight months following the disturbance.

Examination of the logger records from both sites showed a great variety of events and the relationship between the 10-minute values of flow and sediment concentration for the complete period of records showed an extreme amount of scatter in the data. Scatter in suspended sediment data obtained from river water samples has been reported from many previous studies, especially those in small, headwater catch-

ments. Johnson (1994) suggested that scatter is associated with the number and proximity of small sources of material which release material over short, intermittent periods of time. The data collected from this forest road site supports this idea, with the scatter in the data being due to the irregular release and transport of material from the source site. Interpretation of the data was carried out by considering individual storms with total runoff, mean flow rate, total rainfall, mean rainfall intensity, time since previous storm and total sediment load for each storm computed.

The database was sub-divided into six categories depending on road conditions and the type of event. The road conditions were the unused road and the used road before and after regrading; the types of events were rainfall-runoff or freeze/thaw. Freeze/thaw events were those events which followed a sustained period of sub-zero air temperatures as recorded by the nearby automatic weather station and were selected as these had been reported, by road engineers, to be the most damaging events.

Figure 3 shows an example of rainfall and sediment load values for the period 11-15th November 1994 from the used forest road site following regrading. The discharge and sediment concentrations closely follow the pattern of rainfall, with the largest peaks appearing to coincide with the maximum rainfall intensity.

Analysis of the full data set revealed the following general observations. On the unused forest road, the peak sediment loads, in both rainfall and freeze/thaw events, were mostly less than 1 g/s. For the used road before regrading, the peak sediment loads ranged from 0.2-4.0 g/s during rainfall events. No freeze/thaw events were recorded from this site. For the used road immediately following regrading, the peak loads were 2.5-10.5 g/s during rainfall events, decreasing to 1.1-3.6 g/s eight months after regrading. These results indicate that road regrading had a major impact on the peak sediment loads, with the road regrading producing loads of between 2.5-10.5 times greater than for the unused forest road. These values support the findings of Johnson (1993), who suggested that an eight fold increase in sediment yield from the Kirkton catchment, following the onset of clearfelling, was due to the increased erosion from the forest roads.

The data for rainfall and freeze/thaw events from each of the three road conditions were analysed by relating the following:

total runoff v total rain
total load v total rain
total load v total runoff
total load v flow rate
total runoff v mean rainfall intensity
total load v mean rainfall intensity
total runoff v time since previous storm
total load v time since previous storm

Visual examination of the X-Y plots showed that, for all road conditions, there were good relationships between total runoff v total rain; total load v total rain; total load v total runoff but poor relationships between the others. This was confirmed by the coefficient of determination (r^2) values when a regression analysis was carried out.

Figure 4 shows the regression lines relating total runoff to total rainfall per storm event for the three road conditions and two types of events. The used road before regrading shows the highest runoff for any given rainfall event, closely followed by the unused road. The used road following regrading shows the lowest runoff response, with values approximately one third of those produced on the used road before regrading and the unused road. Runoff, therefore, is more easily generated by the compacted, old road surfaces. *Figure 5* shows the relationships between sediment loads and

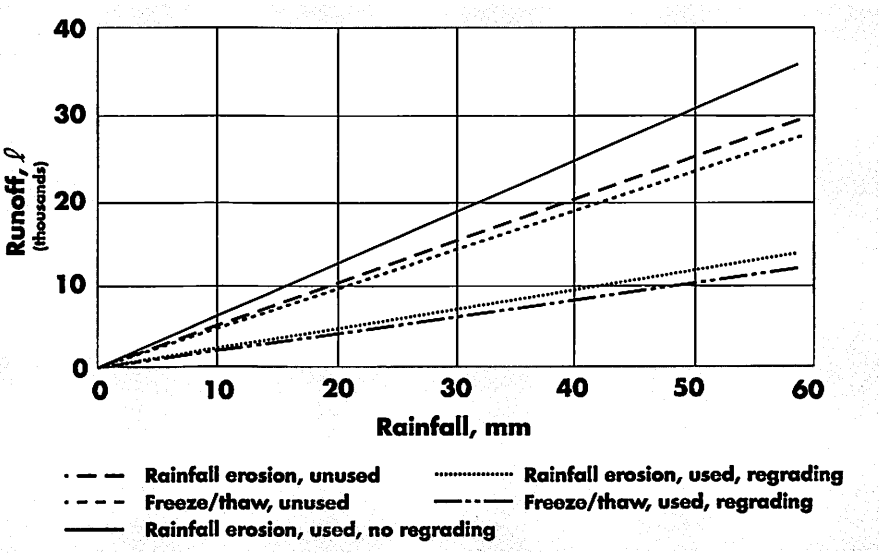

Fig. 4 Total runoff per storm against total rainfall per storm.

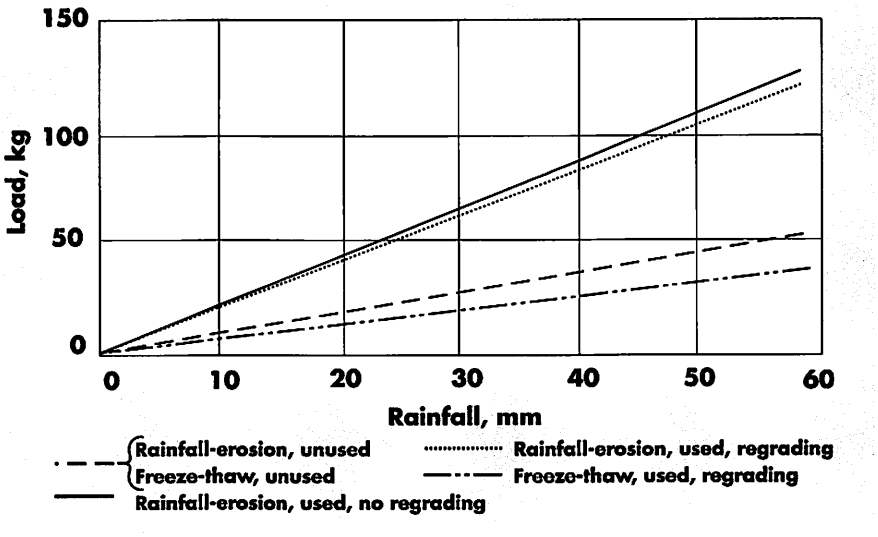

Fig. 5 Total sediment load per storm against total rainfall per storm.

rainfall, with the greatest amount of sediment produced from the used road both before and after regrading in rainfall events. For a given rainfall event, the total sediment load from the used forest road was over 2.5 times greater than the sediment load produced from the unused forest road. When relating sediment load to storm runoff *(Figure 6)*, it is the used road following regrading in rainfall events which has the greatest sediment load for a given quantity of runoff. For example, 4000 litres of runoff produced almost 40 kg of sediment on the used, regraded road; a figure over five times greater than the sediment load produced for the same volume of runoff on the unused road. Sediment load from the used road before regrading is still double that from the unused road. The used forest road, during periods of freeze/thaw, although having the least runoff and load for a given rainfall event, has the third highest pattern of sediment load per unit of road runoff. The values, however, are still below those produced under rainfall conditions.

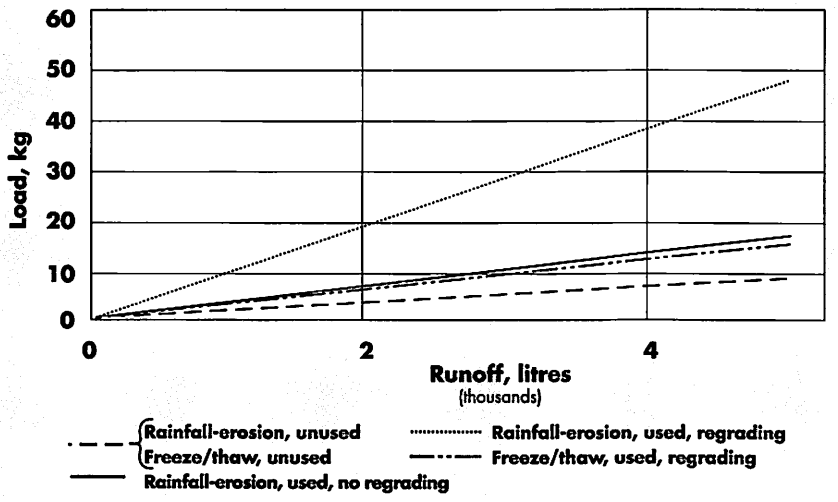

Fig. 6 Total sediment load per storm against total runoff per storm.

The results of the size analysis of the sediment collected in the barrels showed that, for both roads, 75-85% of sediment load transported from the road surface was equal to or less than 355 μm in size. A series of sediment samples taken from site 2 showed that, before and immediately following the regrading, the size distributions were very similar and contained a very high proportion of very fine material. Some three months after regrading, the proportion of fine material decreased substantially. This change suggests that before regrading, when the road was in a poor condition, with deep wheel ruts having formed following the wet winter and heavy use by logging lorries, very fine material was freely available for erosion. Following regrading, fine material was available but in a limited amount. Observations of the road showed that, following regrading, the fine material was gradually washed out of the surface layer, leaving the coarser material to eventually provide protection from further erosion.

5. Conclusions

The following conclusions are drawn from the data collected from the forest roads in the Kirkton catchment, Balquhidder.

a. Rainfall-runoff from the roads is more easily generated from the older, compacted roads.

b. For the unused road, peak sediment loads were less than 1 g/s in both rainfall and freeze/thaw events. For the used road, sediment loads were 0.2-4.0 g/s in rainfall events before regrading, increasing to 2.5-10.5 g/s (2.5-10.5 fold increase) immediately following regrading of the road then decreasing to 1.1-3.6 g/s some eight months after the regrading. Freeze/thaw events produced less erosion than the rainfall events.

c. For individual storm events, the closest relationships were found between total runoff v total rain; total load v total rain and total load v total runoff. Rainfall duration, intensity and antecedent conditions were not found to be important controls in the erosion process. For a given amount of storm runoff, the total load for the used road before regrading was twice the load for the unused road, and the total load for the used road following regrading was five times the load for the unused road.

e. 75-85% of the sediment derived form the roads was very fine, equal to or less than 355 μm.

Results from previous studies in the USA, New Zealand and Australia showed that road gradient, length, intensity of use and climate were importan controls on road surface erosion rates. The reported increases in sediment loads following high use of the roads by logging lorries were 2-7.5 times the loads when the roads were unused. This compares very favourably with the results from this study which suggested a 2-10.5 fold increase.

A cycle of erosion appears to exist in these forest roads with unused, compacted roads having relatively little erosion due to the development of a protective surface. Once the road is used by heavy lorries in wet weather, wheel rutting occurs which exposes fine material to the erosional processes. Regrading removes the rutting but leaves the road surface without a protective layer until the fine material has been washed-out and the remaining coarser particles can redevelop the protection. A number of road construction techniques have been tried in other studies, with the use of gravel surfaces appearing to give the best results. Management guidelines which could also be developed from this work should concentrate on the timing and priorities for road maintenance.

Acknowledgements

Rivers Authority, but the opinions expressed in this paper are those of the authors and not necessarily those of the NRA. The authors would like to thank Mr R Milne of the NRA for his support and advice throughout the project and the Forestry Commission Engineers who provided valuable information on current practices throughout the UK.

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Branch Diary

Scottish Branch

Wednesday, 24 January at 19.30 h
Royal Hotel, Bridge of Allan.
Members' night. Various members speaking on a selection of topics after a bar supper.

Wednesday, 21 February at 10.00 h
Isle of Skye Hotel, Perth.
Annual Conference: *Fruit & vegetables, chasing quality.* Followed by AGM.

Southern Branch

Thursday, 22 February at 19.30 h
Rycotewood College.
Hydraulic fluid contamination and filtration. Oliver Dunthorne, Danfoss.

Wednesday, 13 March at 19.00 h
Venue to be advised.
AGM, dinner, and after dinner address.

South East Midlands Branch

Monday, 5 February at 19.30 h
Silsoe College.
Human factors related to agricultural vehicle and cab design. Dr R McCaig, HSE.

Tuesday, 13 February at 20.00 h
Silsoe College.
Three short papers by Young Engineers. An IMechE Automobile Division meeting: guests welcome.

Monday, 4 March at 19.00 h
Silsoe College.
AGM followed by talk. *Design of machines for pea harvesting.* K Brown, FMC.

West Midlands Branch

Monday, 12 February at 20.00 h
MF Training School, Stareton, Stoneleigh.
Ford 70/Fiat G Series tractor developments. Les Heath, Ford New Holland..

Monday, 11 March at 19.15 h
Bomford Turner.
AGM, followed by talk and demonstration. *Stirling engines.* Norris Bomford.

Wrekin Branch

Monday, 12 February at 19.30 h
Harper Adams Agricultural College.
Coppice harvesters. R Deboys, Forestry Authority Technical Development Branch.

Monday, 11 March at 19.30 h
Harper Adams Agricultural College.
AGM and talk. *Engineering in the food industry.* J Evans, Premier Beverages Ltd.

Agricultural & Biological Engineering: new horizons, new challenges

John Gowing

The traditional base of agricultural engineering in UK is in decline and the profession must respond positively or perish. Therefore this conference, which was arranged in September 1995 to celebrate 50 years of agricultural engineering at the University of Newcastle upon Tyne, provided a timely opportunity to debate the challenges that face us as we approach the millenium. It was proposed that new opportunities for expansion and diversification of employment opportunities present us with the challenge of reforming the profession as Biological Engineering (Gowing, 1995).

The conference attracted over 100 participants from 29 countries with invited keynote speakers from Europe, USA and Asia. Five technical sessions over two days dealt with different areas of activity within the domain of biological engineering and sought to identify needs and opportunities for engineers resulting from the explosion of knowledge in the biological sciences and the growth of biologically based industries.

Session 1 Environmental Management and Amenity Engineering

The changing and diminishing role of production agriculture in the rural economy was a signal to land owners to consider participating in those parts of the rural economy where there was potential growth (industry, tourism, leisure, housing), provided the right mix of attributes could be created, usually at a scale well beyond that of the individual farmers. Land has a pivotal position in environmental management.

There was agreement that those engaged in production agriculture will be forced down a sustainable route by regulations to control diffuse pollution and by a market structure which will expect complete control over, and documentation of, the food production chain. Engineering will make a crucial contribution to adoption of sound, sustainable policies by development of biophysical/ecological/economic decision support systems.

Dept of Agricultural and Environmental Science, University of Newcastle, NE1 7RU

Session 2 Biosystems and Ecological Engineering

Taking up the theme of the damage which has been inflicted on the natural resources base, our keynote speaker posed the question: "What could and should be done to change human activities, including agricultural practice, in a direction so that they no longer pose a threat to our own existence?". He then proceeded to outline the key principles of ecological engineering based upon knowledge of the structure and function of ecosystems. He argued that modern agriculture violates these principles and demonstrated how agricultural practices should be modified to satisfy them.

Other speakers discussed the application of these key principles in design and management of other important biosystems including: industrial fuelwood production systems; wetland habitats and microbial bioremediation systems for treatment of contaminated land. There are many potential areas of application where the opportunity exists for much closer collaboration between ecologists and engineers.

Session 3 Bio-instrumentation and Environmental Measurement

We were reminded by our keynote speaker that most, if not all, scientific discovery was preceded by invention and measurements. No discipline is exempt and development of bio-industries will depend upon developments in bio-instrumentation. The most important concerns that are seen to be driving these changes are:

- the new trend in quality control - a policy of zero defects;
- the importance of precision farming and precision processing;
- environmental regulations;
- the impact of biological engineering on medicine through in-vivo, non-invasive diagnostics.

He concluded his paper by provided some futuristic examples of measurement techniques within the domain of biological engineering.

Other speakers provided specific examples of new developments:

- applications of imaging spectroscopy and spectral fingerprinting;
- sensing mechanical properties of fresh produce for quality control;
- use of nuclear magnetic resonance (NMR) techniques to provide information onplant and animal tissue;
- developments in application of ion-specific electrodes in continuous monitoring of the environment.

We have seen enormous advances in analytical capability. Instruments that were once room-size are now bench-top size, while bench modules have become pocket-size. These advances will continue and biological engineers will be there.

Session 4 Bio-materials and Bio-process Engineering

A promising response which meets the requirements of sustainability lies in the development of production systems in which all the products of photosynthesis are recycled in the biosphere. Using oil-palm as an example of a crop with a high rate of photosynthesis, our keynote speaker pointed out that of the 30 t/ha dry matter which is harvested annually, only 5 t/ha (32% of the total energy) is recovered in the oil. The challenge is to recover the remaining energy. Laboratory studies have clarified the micro-

organisms and pathways capable of digesting the fibre and converting it into glucose and xylose, which could become the feedstock for further fermentation processes that produce biofuels and bio-ploymers.

Another important application of biotechnology in treating municipal sewage sludge through composting was discussed by a later speaker. Other speakers dealt with properties of biomaterials and considered the use of this knowledge in processing industries.

Session 5 Future Trends in Agrotechnology

Before looking to the future, our keynote speaker reminded us that past developments in technology for agriculture have increased production and improved labour conditions far beyond what could have been anticipated only 50 years ago. The successes of the past have generated new possibilities and new demands in the form of further reductions in production costs under more severe environmental constraints. Future developments will include:

- site specific farming depending on the integration of information on soil variability, yield variability and precise equipment location together with control algorithms and equipment advances that will permit a more responsive approach to use of agrochemicals;
- environmentally-friendly improvements in crop protection through sprayer design, detection technology for real-time recognition of weeds and diseases, control systems allowing patch spraying, advances in mechanical weed control;
- concurrent engineering approaches to design of mechanical handling systems which will incorporate knowledge of biology, mechanics, electronics, etc.

These themes were further discussed by other speakers who dealt specifically with developments in precision farming and mechanical weed control and opportunities for developments in renewable energy.

The conference continued on the third day in a joint meeting with IAgrE on the theme of education, training and professional development which sought to address the question: What are the educational requirements of the next generation of agricultural/biological engineers in view of the employment opportunities likely to be available to them in future biologically-based industry? This will be reported more fully in a future issue of the *agricultural engineer*.

Reference:

Gowing J W (1995). Biological Engineering: into a new era for the profession. *agricultural engineer*, **50**(2):29-30.

Virile detergents

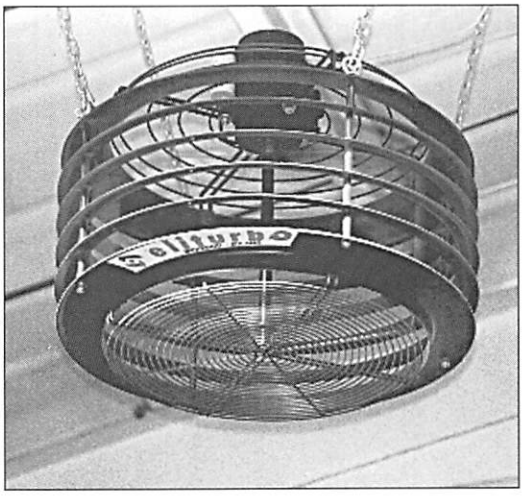
A low sperm count in male livestock may be down to the presence of hormone mimicking chemicals contained in sewage based fertilisers sprayed on to farmland. Detergent based alkylphenol ethoxylates (APEs) get washed into the drainage system and into the sewers. Sewerage sludge sprayed onto farmland as fertiliser has been found to contain APs, degraded down from APEs, which could be harmful to grazing livestock.

The new range of **Ark** industrial cleaners contains non-ionic surfactants which have been designed to be both biodegradable and non-oestrogenic and will lead the way in the development of safe and efficient alternatives that pose no threat to human or animal health or the environment. The range covers heavy duty detergents and degreasers down to food industry compatible dry hand cleaners, based on ground olive stones.

Ark Campaigns (UK) Ltd, London. Tel: 0171 439 4567

Air mixing unit for livestock

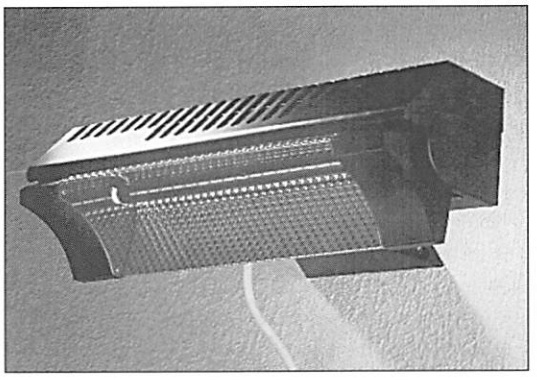
Improved ventilation, moisture, heat and odour dispersion are claimed for the Eliturbo air mixing unit. A form of centrifugal fan rotor draws air from both above and below the suspended unit, mixing it then expelling it laterally. The circulation currents set up improve uniformity of temperature and humidity distribution in poorly ventilated buildings, or allow reduced minimum ventilation rates in controlled environment rooms. By recirculating warm air from upper levels, heating costs can be reduced.



S & P Coil Products Ltd, Leicester. Tel: 0116 249 0044

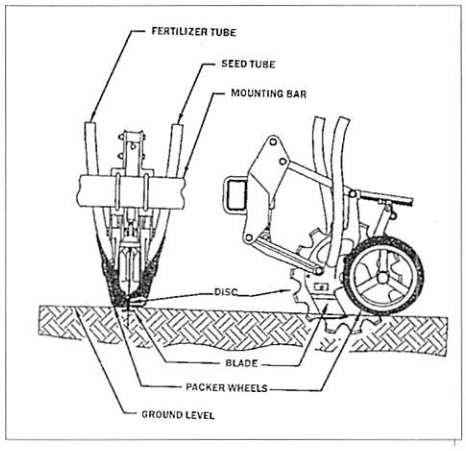
All weather heater for farm buildings

Short wave radiant heating can now be used outdoors or in poorly protected farm buildings. Emulating sunlight, the short wave heater does not directly heat the air, but warms people and objects. Heat output is highly controllable, with full output being produced in little over one second. The manufacturer recommends it for exterior, non-enclosed applications where use is intermittent. The 1.5 kW Vector RP is claimed to be the first rain proof, short wave heater to be launched in the UK.



FGS, Rochdale.
Tel: 01706 38271

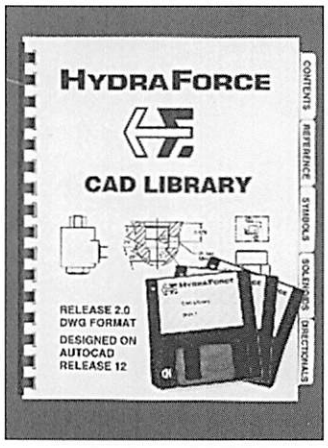
Cross slot no-tillage drill



The Cross Slot™ drill originated from research at New Zealand's Massey University. It is based on 15 years of biological research backed by 10 years of engineering development and field testing in New Zealand, Australia, Canada and the USA. The Cross Slot is created by an inverted 'T' shape opener, for which increased seedling emergence is claimed, especially in poor soil conditions. High levels of surface residues are handled, and utilised as the slot covering medium without coming into contact with the seed. Seed and fertiliser can be separated horizontally in the slot, and speeds up to 16 km/h are possible. Several years of testing by USDA have shown an average cereal yield benefit of 13% compared with conventional tillage and other non-tillage technologies. The exploiting company will shortly be seeking European licencees.

Cross Slot Technology Ltd, PO Box 22-717, Auckland, New Zealand.

CAD Library of cartridge valve components and schematics



A library of CAD-generated hydraulic cartridge valve components and schematic diagrams simplifies the task of system designers using computer aided design techniques. Using the library, a designer can call up virtually any HydraForce cartridge, cavity, port, symbol or housing, edit the image if necessary, and drop it into a drawing.

The HydraForce CAD library is supplied on three 3.5" high density, DOS-formatted floppy disks and is compatible with AutoCad release 11 and up. A printed and bound reference manual is also included.

Enquiries to: Mr Ian Askew, HydraForce Hydraulics Ltd, Newcomem Works, Bracebridge Street, Birmingham B6 4PF. Tel: 0121 359 2062

Precision soil moisture sensor

ThetaProbe is a new way to measure volumetric soil moisture content. It combines ease of use and accuracy with low cost, to give scientists and land managers unprecedented access to precise soil moisture data. The device has been jointly developed by the Macaulay Land Use Research Institute and Delta-T Devices. It uses a new technique (patent applied for) that matches the accuracy of other soil moisture devices, but without the expense and complexity.

The probe is inserted into the soil and connected to a single analogue channel of a data logger. Most types of logger are compatible, and Delta-T offers data loggers capable of handling both small and large numbers of probes. Alternatively, a hand-held readout unit can be used. *ThetaProbe* achieves accuracy to within ±0.02 m+.m-+. Soil specific calibration, if required for optimum accuracy, is very straightforward.

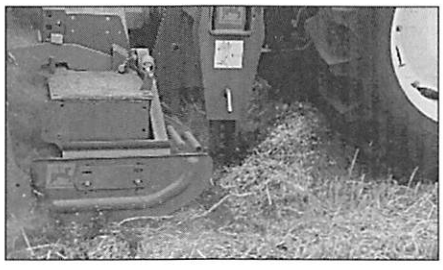
Delta-T Devices Ltd, Cambridge. Tel: 01638 742922

Tine assembly for non-plough drilling

The latest TL type tine assembly for Amazone power harrows and drills - separately and in combination - provide an initial soil loosening and trash burial facility that, in most soils, will achieve a firm, fine seedbed in non-plough situations. Where the soil is ploughed the device gives excellent soil movement, levelling and pan breaking activity ahead of the power harrow/drill.

Share options include those with 300 mm wide wings for straw incorporation on heavy soils, and with 600 mm wide wings for lighter soils where greater working depth is possible to achieve movement across the entire working width. Maximum working depth with both types is 25 cm; the normal working depth range is from 15 to 25 cm.

The TL attachment is easily detached in situations where it is not required. The combined TL/power harrow components can be used separately in conditions of heavy trash or seed burden. Germinated weed and volunteer seeds can subsequently be completely removed in the following seeding operation.



Trials with the full combination in a non-plough situation in Germany have demonstrated higher yield potential compared to both comparable non-plough drill systems and to conventional ploughed and cultivated plots.

Amazone Ltd, Saltash, Cornwall. Tel: 01579 351155

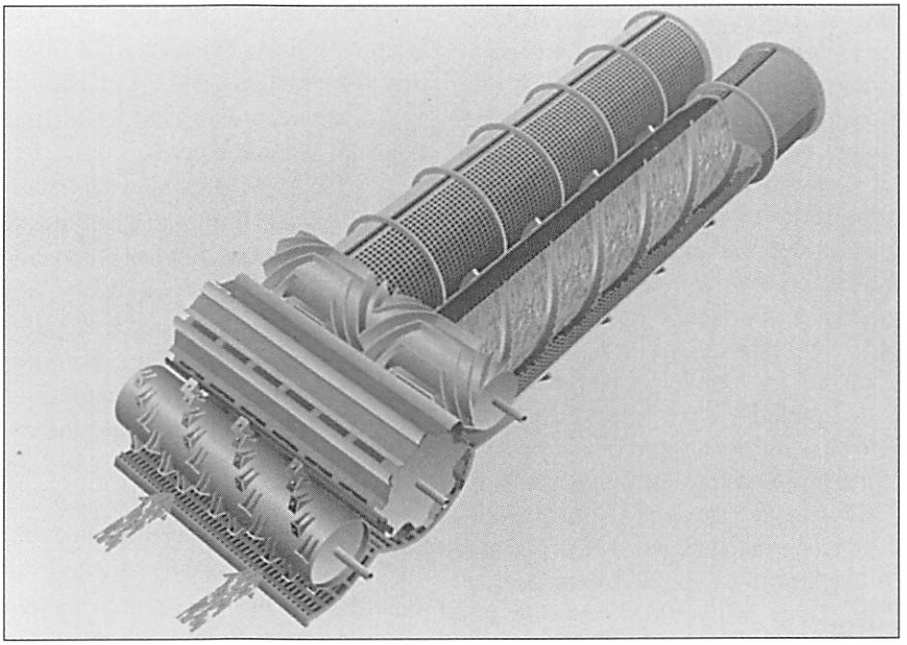
A new Claas of combine

The new Lexion 480 combine has more harvesting capacity than any other machine currently available. With output at around 40 tonnes/hour, the machine is aimed at the arable farmer with 600-800 hectares of combinable crops. Whilst a totally new design, the Lexion incorporates many features that have been shown to enhance combine performance and are currently available on the Claas Mega range. These include the Autocontour cutterbar control system, Accelerated Pre-Separation (APS), the 3D sieve system for hillside work and the newly launched Vista cab.

From the cutterbar the crop is conveyed to the APS threshing system. An accelerator in front of the main drum smooths the crop flow and separates loose grain.

The threshing may be conventional but the separation is definitely not because here Claas have introduced a new system called "Rotoplus". The crop from the threshing drum is divided into two streams by a "chevron" impeller and is fed into two longitudinal rotors. This completely new separation system is designed to get the remaining grains from the straw as it rotates and transports the crop to the rear. The grain falls through the perforated rotor covers onto the returns pan for cleaning. This forced separation is very intensive and lays the foundations for the highest possible output.

With cutterbars up to 9.0 m wide at the front Claas has recognised the need for a totally new approach to the distribution of chopped straw and chaff at the rear. From the chopper the straw is mixed with the chaff in two distribution fans which then blow the material through two funnels. These funnels swivel from side to side ensuring an even distribution of chaff and straw across the full width of the cutterbar. Width of spread can be adjusted to match cutterbar widths. Switchover from chopping to swathlaying is easily done.



The Lexion is equipped with CEBIS - Claas Electronic Board Information System - a central computerised control system. On the monitor screen to his right the operator can display and select a host of information on operational and maintenance functions. Machine settings for various crops are pre-programmed in the computer for the operator to select. Alternatively, using the computer he can make his own adjustments which are then stored for future use.

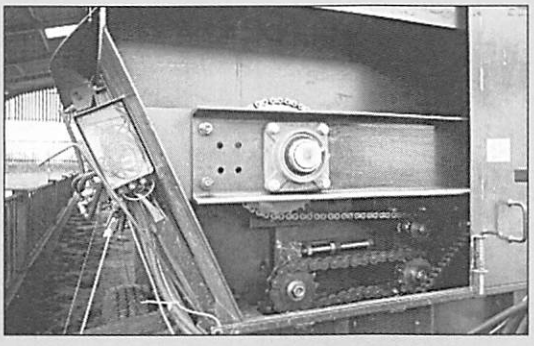
Lexion has a built-in yield meter, moisture meter and area meter that records and stores harvest data and stores in it the Cebis memory providing the basis for yield mapping. Recorded on a chipcard this data can be transferred to the farm office computer for later analysis.

Claas UK Ltd, Bury St Edmunds, Suffolk. Tel: 01284 763100

Feed mixer trailer

A new complete diet feed trailer is being marketed by a new direct sales company DIRECT fm, an offshoot of Bill Butterworth's IF International. The company claims this is "probably the best feed mixer trailer in the world", and challenge anyone to prove that they have a more thorough mix. Built by a consortium of small manufacturers, the trailers offer a very low profile, electronic weighing and left or right side unloading using breakaway conveyors. An attachment to chop straw and silage bales and beet pulp will be available shortly. By utilising cheaper straight feeds, the machine aims to increase margin over total feed costs.

DIRECT fm, Pontypool.
Tel: 01495 785394



New gear concept from PIV

The new Posired 2 package of helical spur gears will make it possible to solve even the most complex of drive problems literally 'off the shelf'. The savings for customers will be in both time and money. The package is a compact and highly versatile module embracing a small nucleus of compatible components which can be assembled in a myriad of combinations. The range offers nineteen sizes from single through to four stage helical gearboxes together with 2-4 stage bevel/helical gearboxes. Torques of up to 460,000 Nm with ratios from 1.25 to 710 can be readily accommodated.

Virtually silent helical spur gears are case-hardened and ground with a corrected tooth profile to optimise their load carrying capacity. The bevel/helical gearboxes incorporate 'Klingelnberg' spiral bevel gears. Horizontal and vertical mounting positions are possible as standard. The modular design enables easy incorporation of motor bell-housings; backstops, auxiliary drives, brakes and clutches or with a flange for power take-off applications if required.

Posiva Works, Scunthorpe.
Tel: 01724 281868

Permanent plasticity of plastic sealant

The continual replacement of iron, brass, bronze and copper pipes and fittings by plastic parts have created a need for a specialist sealant. Loctite claim to have now met this need with 5331 Plastic Pipe Thread Sealant. Main markets for Loctite 5331 are expected to be, industrial water systems, process plants, sewage treatment, drainage projects, irrigation and swimming pools.

The large gaps between mating treads of plastic fittings make traditional sealants unsuitable. Solvent based products can induce stress cracking. This means poor gap-filling and leakage.

When tape, hemp and non-curing sealants are used greater quantities are needed, increasing application time, cost and the risk of contamination within the pipe system. The new 5331 sealant does not have these disadvantages. It is a solvent-free, non-hazardous, acetoxy silicone product that only requires atmospheric moisture to initiate a cure. This means that it will cure at very low temperatures.

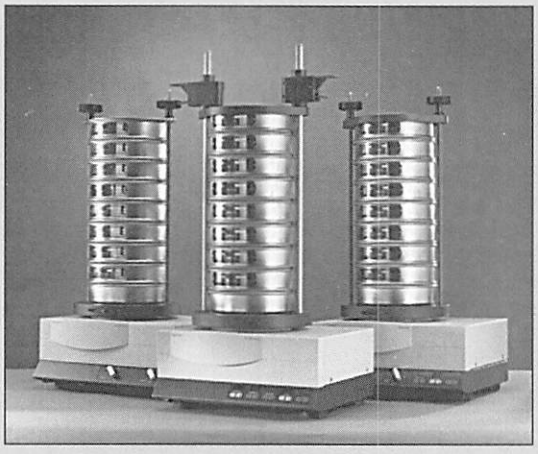
A one-part product, 5331 is applied direct from its 100 ml tube onto both female and male threads. Once the joint is assembled, the sealant gives an instant seal of 0.5 bar water pressure (measured on 1" fittings). Approximately twelve hours later, irrespective of ambient temperature, it will have cured fully to give a lifelong seal against water pressure of 3 bar at 90°C. This seal will remain flexible between -65°C and 250°C. During tests using water/glycol mixture Loctite's latest sealant maintained a leak-free seal during 12 months of continuous thermal cycling between 20°C and 90°C.

The sealant is classified as "low strength". Release torque has been kept deliberately low to ensure easy dismantling of fittings. ISO 10964 tests, for example, substantiated breakaway torque of 1.5 Nm and prevailing torque of 0.5 Nm. These values are maintained at temperatures up to 150°C.

5331 is suitable for hot and cold water systems using Polyacetal, Polyethylene, PVC or combined plastic/metal components. It has the WRC and the German KTW Approvals for potable water.

Further information from Colin Chapman, Loctite UK Ltd, Watchmead, Welwyn Garden City AL7 1JB Tel: 01707 821000 Fax: 01707 821200

Analytical sieve shakers



Three models of sieve shaker from Restch offer differing levels of sophistication, aimed at meeting the needs and budget of every customer. All are equipped with a maintenance free electromagnetic drive via a 6 leaf spring to give 3 dimensional, circular material movement. The top model utilises a microprocessor to control amplitude for reproducible analyses. An RS232 serial interface allows control of the instrument by PC.

The company produce a range of laboratory equipment for grinding, sizing, dividing, feeding, drying and mixing solid samples.

Retsch (UK) Ltd, Salford. Tel: 0161 877 7464

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