IAgrE Journal

# Landwards

Volume 54 No. 4 Winter 1999


Agriculture • Forestry • Environment • Amenity

# FOOD
# FOR THOUGHT

**Annual Conference**
of **The Institution of Agricultural Engineers** with the **Annual General Meeting** and **Awards Ceremony**

*Presidential Address:*
**Geoffrey J H Freedman**

Conference Chairman: **Dr Maitland Mackie**, Chairman of the Board for SAC

Principal Speaker
**Professor Hugh Pennington**
*"Food safety disasters: why do we not learn from experience?"*

**Deidre Hutton**, Chairman of the Scottish Consumers' Council
*"Is it good to eat?"*

**Dr Dennis Legge**, Head of Food Technology Division, Loughry College, Northern Ireland
*"Developing people – for a competitive food industry"*

**Dr Eric Hillerton**, Institute of Animal Health, Compton
*"The equipment to meet milk standards"*

**Roger Balls**, Engineering Consultant
*"Engineering for the benefit of the product and the consumer"*

**Andrew Muir**, SAC Crops Division
*"Monitoring the quality of produce"*

*The conference explores the issues and controversies surrounding the need to meet higher food standards and the response of food technologists and engineers who have to create new machines and systems to enable the farmer and others in the food supply chain to reach and even surpass these standards.*

**Stakis Hotel, Edinburgh Airport**
**9 May 2000**

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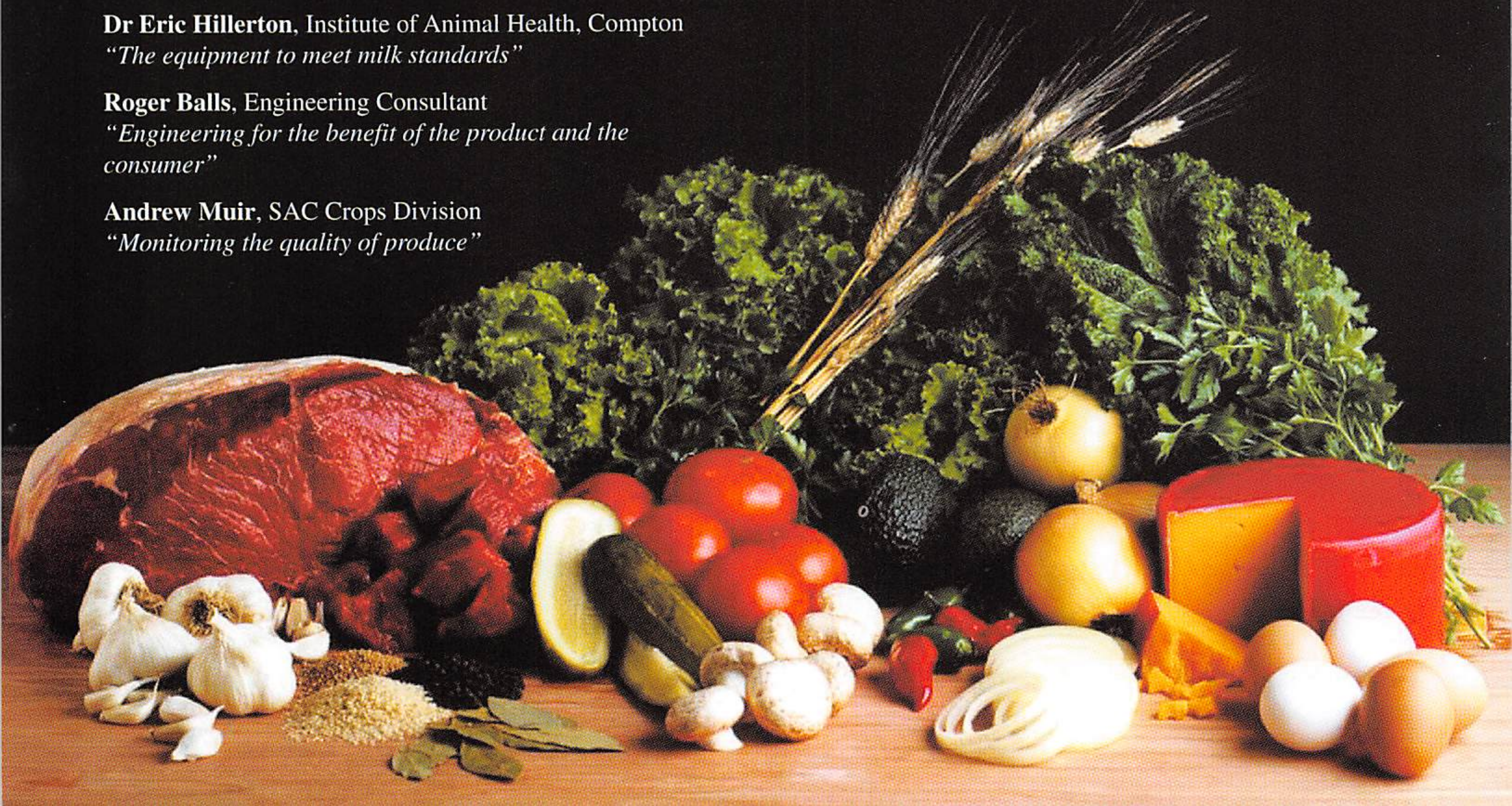

**Landwards**

**The Journal for Professional Engineers in Agriculture, Forestry, Environment and Amenity**

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**Origination** David King
**Printing** Barr Printers Ltd

**Price** £13.00 per copy
subscription £48.00 (post free in UK)

**Publisher**
***Landwards*** is published quarterly by:
Institution of Agricultural Engineers,
West End Road, Silsoe,
Bedford, MK45 4DU
Tel: 01525 861096
Fax: 01525 861660
Email:secretary@iagre.demon.co.uk
Web site at
http: //www.iagre.demon.co.uk

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## News and comment



**Front cover:** *Silviculture in winter – glittering beauty or ice-laden destruction* (*photo: Land Technology Ltd*)



**ISSN 1363 8300**

# Forest road engineering in the UK

*Forest Road Engineering in the UK was covered in detail at the Institution of Agricultural Engineers' Conference on 'Unsurfaced Roads in the Rural Environment' (Hay et al., 1994). Rather than attempting to condense all this detail, this paper provides an overview of the subject and concentrates on recent developments and trends.*

**David Killer**

***This paper was presented at the 1st International Conference on Forestry engineering entitled: 'Forestry Engineering for tomorrow', organised by the Forestry engineering Group of the IAgrE and held at the university of Edinburgh, Scotland, UK on 28-30 June, 1999.***

***David Killer FIAgrE is Head of Forestry Civil Engineering, Greenside, Peebles EH45 8JA, Scotland, UK.***

The role of civil engineers in UK forestry has been changing in recent years. The two disciplines of forestry and civil engineering are beginning to merge as we gradually adopt the concept of forest engineering. Civil engineers now have a better understanding of harvesting and environmental requirements and foresters are being trained in the basic principles of good engineering. This allows a partnership approach to develop with the civil engineer listening to what his forest manager customer needs and then providing a full support service for the whole forest infrastructure.

## Forest road engineering in the Forestry Commission

Forest Enterprise (FE), which is an Agency of the Forestry Commission concerned with the commercial management of its estate, has recently set up a new civil engineering service unit, Forestry Civil Engineering (FCE). Prior to this, civil engineers had been part of the Regional management units and now for the first time, all civil engineering staff (32 engineers, 130 operators and four administrative officers) come under the same management structure. This has allowed a streamlining of management functions and, more importantly, has generated a culture where best practice and value for money are predominant.

Another benefit from the creation of a single forestry civil engineering unit has been the focus on research. Research on low-cost engineering in UK covering choice of surface aggregates, pavement depth, geometrical standards, best construction practice, optimum maintenance, low-cost structures *etc.* has been somewhat arbitrary. To provide a more structured approach, FCE has now established a Research Team to look at all aspects of low-cost civil engineering in UK, and has created a useful link with Transport Research Laboratory, with its broad experience of low-cost roads overseas.

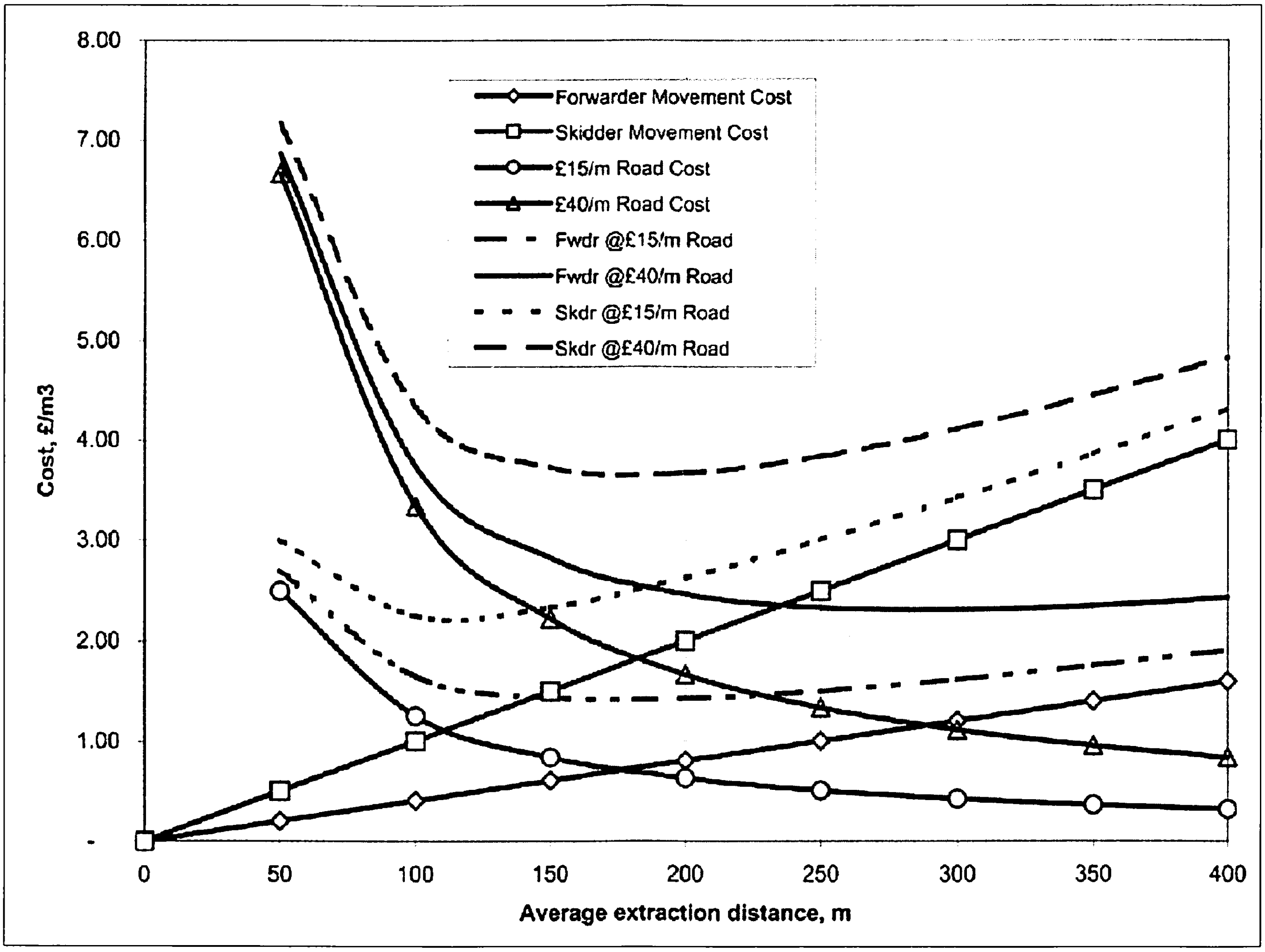


**Fig. 1 Alternative forest road options, based on a skidder cost of £1.0/m³ timber volume per 100 m travel, a forwarder cost of £0.4/m³ timber volume per 100 m travel, each for a timber yield volume of 300 m³/ha**

Forest roads are the responsibility of Forest District Managers but FCE now provides a design, construction, maintenance, certification and consultancy service to each Forest District. In some parts of UK, forest roads are only a small part of the service that FCE provides, with the emphasis being on recreational facilities etc. Engineers in FCE are also involved with the wider forestry issues, such as timber haulage, use of public roads, alternative forms of transport, environmental standards, small scale timber extraction, reservoir inspections, alternative use of structural materials and the design, construction and certification of structures. This broad range of expertise has proved to be valuable to other outside bodies and, as a result, FCE has developed a low-cost engineering service that is applicable to a range of rural engineering needs.

However, this paper will deal with just one part of this total service, *viz.* the safe and efficient removal of timber from forest floor to public road.

## Forest road planning

Statutory planning procedures vary from country to country so I will only deal with planning issues that are generally applicable.

*Economic assessment of forest road options*

It is assumed that the forest planners have established the need for the road and now the optimum location needs to be decided from harvesting/environmental requirements and economic appraisal. Although the concept of optimum road density is a useful guide to planning the extraction routes of a macro-forest, it is not sufficiently sensitive to deal with extraction decisions in a micro-forest situation. Recent advances in the process of forest design have led to much smaller and more irregular shaped felling coupes. With such variations in size, extractions systems and extraction distances, any prescribed road spacing becomes purely academic and a more basic assessment based on best available data on harvesting methods is needed. However, the principles of minimising total costs by balancing movement and roading costs are well established and still provide a means of assessing options. The results of the earlier analyses, which gave optimum road spacings of 1,000 m, and thus a maximum distance from stump to road of 500 m, still provide a good guide at the planning stage.

The increasing complexity of coupe size and shape means that the positioning of a road is going to be a compromise, with some felling coupes not being served optimally. In these circumstances, individual facilities are provided which may include a further short spur road or an increased length of extraction track. The introduction of Geographic Information Systems (GIS) will assist in optimising the road location over a number of felling coupes, by testing extraction volumes and average haulage distances for each option.

**Class A, Main Road**
- Principal haulage route on long term basis
- Constructed to full road specification
- Maintained to high standard
- Limiting features shown on road maps

**Class B, Spur Road**
- Only used by timber lorries for specific purposes
- Specification tailored to suit its purpose
- Full geometric and safety standards
- Unlikely to have high quality, durable surfacing
- Minimal long-term maintenance
- Each usage subject to an individual engineering assessment
- Limiting features noted for each particular harvesting contract

**Class C, Other Roads**
- Roads, other than Main Roads, that have other uses
- Third party access, car park access, rally routes, management roads, *etc.*
- Maintenance dependent on usage
- Not normally used by timber lorries
- Use by timber lorries would be subject to the same individual assessment as Class B roads

**Fig. 2 Annual review of forest road classification**

As road specifications are developed to match particular requirements there will be a greater range of capital road costs and capitalised maintenance costs. This also suggests the need to appraise each roading option rather than apply average road densities to particular harvesting sites.

The chart in *Fig. 1* demonstrates that the 250 m average extraction distance is correct for forwarder extraction to a road with a combined capital and capitalised maintenance cost of £40/m. However, a cheaper road of £15/m serving a skidder site is better at 100 m average extraction distance, or 400 m spacing.

*Environmental planning*
To comply with good environmental practice, UK Forestry Standards and certification requirements, it is compulsory that each project is assessed for environmental impact. In the UK this is a statutory requirement for projects over a certain threshold. Forestry Civil Engineering has a Project Record in each project folder with simple tick boxes, to ensure environmental matters are not overlooked. These include:
- location of roads and bridges to respect landscape and land form;
- avoidance of archeological sites and disturbance of protected species and habitats;
- prevention of adverse impact on watercourses, water quality and wildlife; and
- avoidance of soil damage and erosion.

*Operational planning*
There is a clear advantage in setting out future roadlines well in advance of intended use so that Forest Design Plans can incorporate the line of the road. The objective is to fell the roadline in the year before construction so that the engineer can optimise the planning of his whole programme for the year. The advantages of allowing the final road construction to consolidate prior to use are also well known. Most practicing engineers, however, will recognise that such objectives are rarely achieved!

Planning is not limited to new works, and it is increasingly important that road maintenance activities receive an equal emphasis on good forward planning. This ensures that best use is made of resources, and forest managers have an input on the timing and need for work.

## Forest road classification

Forestry Civil Engineering is currently recommending a change in the forest road classification system to reflect usage, rather than specification. The analogy is with the public road system, where the classification of a particular road is designated on the basis of its function, even though the specification may vary from motorway standard, through dual carriageways to single carriageways with steep sections and tight bends. Any limiting features such as single carriageway or steep section will be readily identifiable from the map.

In the recent past, all FE forest roads have been built to the same standard irrespective of whether they are to carry one timber lorry a week, or 10 a day. As they have been built to the full standard, they are included in the Forest Road Network and maintained, even though they may not be required for another 25 years. We are now looking to reclassify our forest roads on their basis of use, rather than the standard to which they were built. One of the main benefits of this system is that resources can be directed towards priorities, and better engineering judgements made on designs that are fit for the purpose. There will be a presumption that 'main' roads will be available all through the year for use by all types of road vehicles. However, use of spur roads by timber lorries will be subject to an individual assessment for each particular use. Depending on the surface conditions and geometry there may be limitations on season, intensity or type of use.

The main features of this system are listed in *Fig. 2*.

## Forest road specification

The specification of FE's forest roads has also been recently reviewed. This review included an analysis of forest road incidents and the recent developments in timber lorry weights and configurations. No consistent evidence was found to suggest that the current standards are defective. However, in common with most engineering specifications, a tolerance is being introduced which recognises the level of accuracy that is possible with the methods and materials used in low-cost road construction.

The main features of the Road Specification are given in *Fig. 3*.

Any element of a road, which does not meet the standard, is considered to be a 'limiting feature' that is noted on the road maps or timber contract schedules. Unbound surfaces can never be considered as 'steady state', *i.e.* the day after inspection, there could be a washout or forwarder damage to the road surface. For this reason, all users of the forest roads are expected to report any damage or changing conditions. To improve the standard of reporting and rectifying defects, a system is being tested which records details on a shared spreadsheet. If a forester reports a blocked culvert, the Area Civil Engineer will respond with his

**Minimum pavement width**
- 3.4 m (-0.2 m tolerance)
- Widths less than 3.2 m will be 'limiting features', but...
- only short lengths down to a minimum width of 3.0 m will be acceptable

**Maximum gradient** between tangent points - unbound surfaces
- 10% (+0.5% tolerance)
- Within the overall 10% gradient, short lengths of 12.5% will be permitted if horizontal geometry and surfacing materials are suitable.

**Bends**
- Minimum radius of 15 m (to 1.7 m from outside of bend)
- Widened on inside to standard tables (-0.2 m tolerance)
- Hairpin bends can be tighter than 15m radius but will be noted as 'limiting feature'

**Camber/crossfall**
- This is a drainage feature and will only be noted as a 'limiting feature' when adverse

**Surface Damage**
- Noted as a 'limiting feature' when there is damage or severe potholing that cannot be repaired before contract

**Felled width**
- Noted as a 'limiting feature' when tree growth has encroached on the road corridor (this can affect drain maintenance and hence the strength of the road but can also create an obstruction for drivers)

**Road vegetation**
- If any vegetation on the running surface cannot be removed prior to the contract it will be noted as a 'limiting feature'

**Fig. 3 Forest road specification**

proposed remedial action. Similarly if an engineer reports timber stacked in a ditch, the forester will make a response.

Once the 'limiting features' have been identified it is still the responsibility of the road user to do their own risk assessment to ensure that the vehicles proposed are suitable for the conditions pertaining at the time.

Typical cross-sections are given in *Fig. 4.*

## Forest road design

In many forests, the cost of constructing roads is the largest single expenditure prior to clearfelling. With forestry in UK being a comparatively low profit industry, it is vital that road construction costs are kept to a minimum. There is little scope to reduce geometric standards, so most savings are to be made in the design of pavement and the methods of construction.

*Pavement design*

Although we are well aware of the limitations of using a California bearing ratio (CBR) type approach for pavement design, it still forms the basis of our thickness design. Practical engineers know that the heterogeneous nature of most upland forest soils negates any attempt to find a consistent CBR value. However, experience of similar soil conditions usually allows a CBR estimate to be made, so that the tables of pavement depth for a given CBR and water table depth can be used for design and estimating purposes. The time of year and moisture content of the soil have a huge influence on the bearing capacity and the actual construction depths will vary accordingly. In certain conditions the Dynamic Cone Penetrometer or the 'Army' Soil Assessment Cone Penetrometer can be used to give in-situ CBR measurements.

It is frequently the best solution to create a capping layer using readily available materials and to let it dry out and achieve a CBR of around 20% before placing the pavement material. If this can be achieved, a reduced thickness of paving can be assumed in the design.

The traditional method of CBR design works on the fatigue of the whole pavement (based on flexible and rigid pavement designs) and sub-grade after a certain number of standard axles. This does not readily apply to unbound surfaces where there will be localised stresses and damage that can lead to failure well before the design life of the road has expired.

The CBR method of design also does not account for the intensity of use. The influence on likely damage from high intensity usage varies in proportion to the moisture content of the surface material. A poorly compacted and impermeable surfacing with a high moisture content will be subject to high pore water pressures after loading. If the surface is subject to a further load before the pore pressures have dissipated, there will soon be excess pore pressure and loss of shear strength, resulting in shear failure and rutting. The depth of paving will spread the load and prevent sub-grade failure but the choice of surface materials for high intensity use is equally important to prevent surface failures.

The likelihood of this type of surface failure is minimised by ensuring maximum compaction of the surface (and hence minimum voids) and control of surface and ground water.

*Control of surface water*

Surface water is controlled by having a sealed surface and a road that sheds surface water by means of camber or crossfall. Ground water is controlled by providing and maintaining roadside ditches and regular cross culverts. Ditches should be at least 150 mm below the formation level to control the water table and at a gradient of 2%-6% to ensure flow. Over-deep ditches are unnecessary, dangerous, hard to keep clean and a barrier to harvesting. Open ditches adjacent to roads across peat do not serve a useful purpose and allow more transverse movement. Particular care is needed at the design stage to ensure that surface water from the road is not allowed to contaminate watercourses. This is avoided by use of cross culverts before the ditch discharges into the watercourse and by careful use of vegetation.

*Other design features*

Other features that are considered at design stage are:

location, type and size of culverts and bridges;
special harvesting facilities (not always known at design stage);
location, development and restoration of quarries;
clearing and felling widths;
location of passing places and turn-rounds;
site hazards and Safety File;
location and protection of any

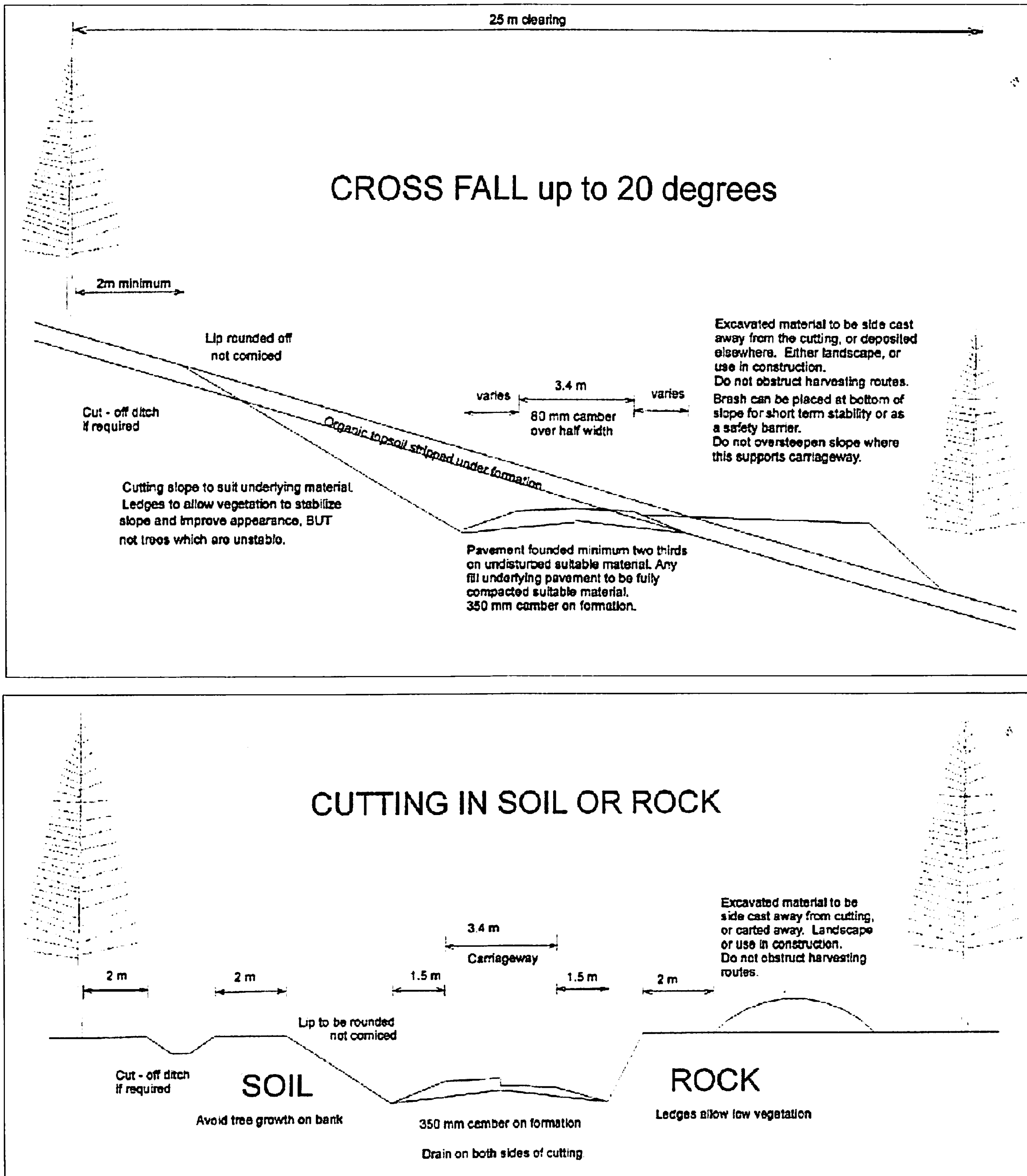


**Fig. 4 Typical road cross sectional details**

public or private utilities;
closure of footpaths and public safety; and
access on to public roads.

## Forest road construction

*Project management*

There is a certain mystique to the non-engineer about building a bridge or using explosives. It has to be acknowledged, however, that in the case of a forest road, unless it is being built across areas of particularly difficult terrain, geology or landslip potential, it is not perceived as a major engineering feat. It is, however, undoubtedly a major logistical feat to ensure that men. materials and machines are all working to their optimum in difficult physical surroundings. Experienced supervisors are essential to avoid wasting time and money with poorly co-ordinated resources.

Minimum cost and low environmental damage are the main targets of the site engineer. However, this has to be achieved within the bounds of a plethora of legislation and with the safety of all personnel as paramount. With this last point in mind, all operations


**Fig. 5 Excavating rock adjacent to the roadline**

are subject to a Risk Assessment and many to the more rigorous demands of the Construction (Design & Management) Regulations. The Project Record form ensures that the engineer has complied with these safety requirements.

*Choice of machines and methods*

With the exception of North and West Scotland, most of the large FE forest road construction programmes are nearing completion. Road squads and machines are being adjusted to suit the change in emphasis from road construction to road maintenance and other support functions. There is a greater stress on flexibility and multi-task machines and operators. Sometimes, this can be most cost effective by using plant-hire and contractors.

This need for flexibility has led to greater use of 360° excavators rather than the traditional angle-dozers. The excavators are used for formation, culverts, ditch clearance, quarry ripping and loading. 20 t machines are used for general application with 13 t machines being used on ditch clearance, *etc.* Larger excavators are generally hired in to deal with harder formations or quarry work. The most difficult and expensive formations are (a) rock and (b) peat.

*(a) Rock formations*

Blasting of roadlines and quarries is essential in much of the West. Although the tight shales and schists are hard to move, they do not provide a durable material suitable for long-term surfacing needs. A simple Aggregate Impact Value test is used to assess the suitability for each type of rock for use in the formation or pavement.

*(b) Peat formations*

In the more difficult areas roadlines frequently alternate between extremely hard rock and soft peats. This leads to particular problems with the choice of machines and programming the work to keep them efficiently occupied. Our experience has shown that geogrids or membranes are only economically justified in the most extreme cases. The normal practice is to use a brash corduroy across the peat followed by locally won material to provide a platform without puncturing the surface and losing that limited, but important, surface strength. At shallow peat depths of up to 1 m. it is generally cheaper to remove the peat providing there is a sound sub-grade. Other methods of crossing peat are used with variable success; these include the mineral reversal method, use of upturned stumps, preloading and drainage. Some of these methods are shown in *Fig. 6*.

*Selection of road surfacing material*

The component costs of an upland forest road show that the production, haulage and placing of the road pavement are often in excess of 50% of the total cost. The road surfacing has the greatest influence on the cost and performance of the forest road.

Road surfacing can commence once a suitable formation is available that is drained and capable of carrying stone wagons. The selection and placing of the road surfacing is the key to a successful road. Once placed and compacted, it should be a dense and durable surface of well-graded material that will withstand direct wheel loads, prevent ingress of surface water and be easily maintained. This is ideally achieved by using a crushed rock, which has been blended to a grading similar to Type 1 sub-base. With experience, the same end product can sometimes be achieved by using a larger crushed rock that will fragment under the roller to provide the same mix.

It is at this point that many forest roads go wrong. Having planned and designed the road, prepared the formation and provided the surfacing material, it is placed and compacted in less than optimal conditions. The theory of optimum moisture content and percentage of voids achieved through compaction is well known. Due to the logistics of planning machine movements, however, the final paving material is often placed and compacted at any moisture content and then the machines move away many miles to the next job. This leads to poor compaction, excess voids and potential failure of the road, especially if there is immediate use in wet conditions.

## Forest road usage

The service provided by a forest engineer continues after road construction to include guidance on the safe use of the road, provision of harvesting facilities and ongoing repairs and maintenance.

*Safe use of forest roads*

Forest engineers need to be aware of changing trends in the type of forest road usage. In UK, for example, the statutory limits on lorry weights and configurations have recently changed. Greater axle loads are now permissible and if tri-axle tractor units raise their tag axle (an illegal practice which the industry must outlaw), forest roads are subject to even greater loads. Most tri-axle trailers now have 'super-single' tyres, which place greater loads at the edges of the forest roads and tend to create single tracks and scrub on tight bends. These changes create more damage and problems but are an

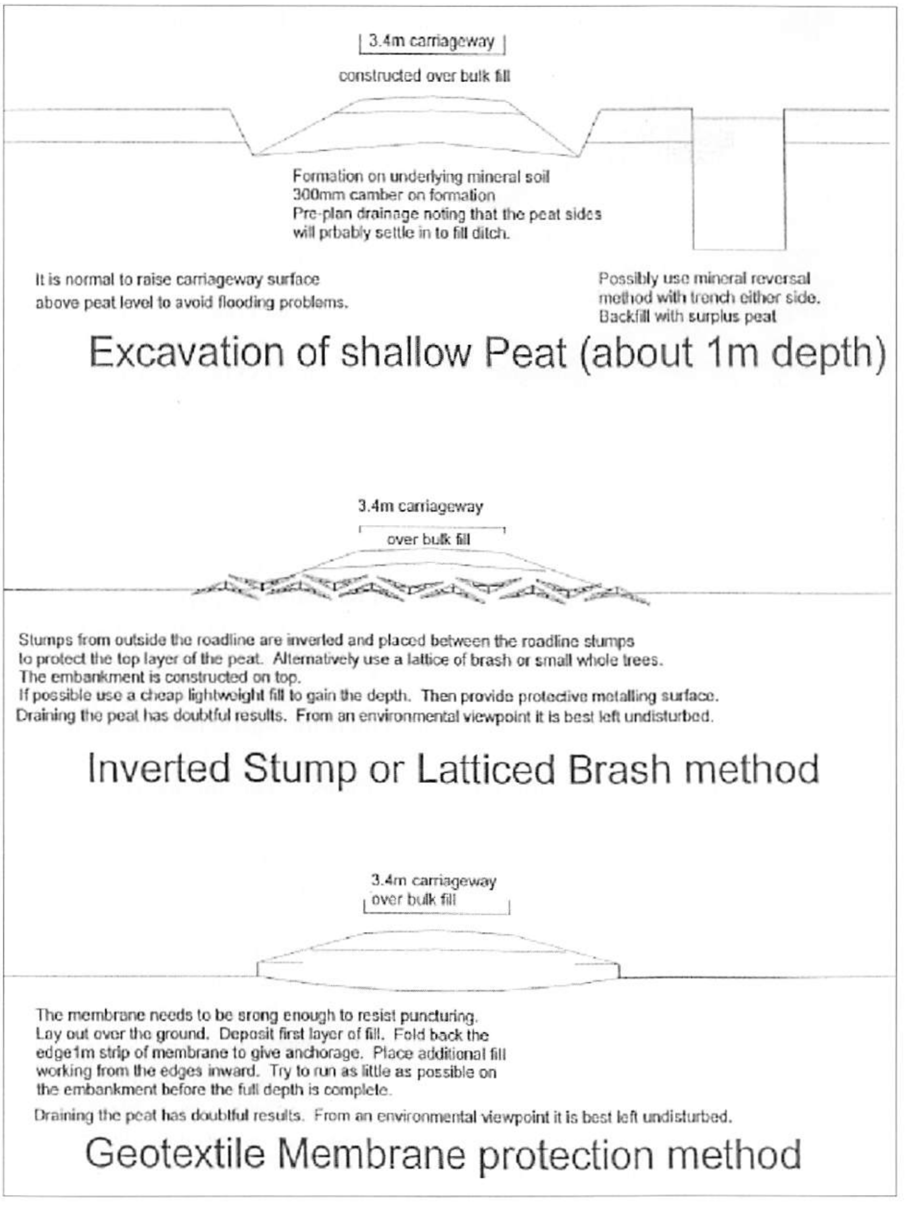


**Fig. 6 Roads across peatland**

inevitable result of market forces demanding greater payloads.

Forest engineers need to respond to these challenges and adjust specifications to suit and to provide guidance on how to limit any increased damage to the forest roads and bridges.

*Interface with harvesting*

Road engineers frequently bemoan the damage caused to forest roads by the 'mis-use' of harvesting vehicles. There are many cases where good harvesting practice can avoid the need for forwarders to use the forest road to offload their load of timber (especially if they are using traction aids). Well designed stacking points and spur tracks also keep damaging vehicles off the forest road and avoid conflict with the timber lorries and other users. However, the forest engineer needs to appreciate that in some circumstances there are no alternatives and there should be active co-operation between the engineer and forester so that the road design can incorporate features to withstand this dual use.

*Repair and maintenance of forest roads*

The frequency and standard of maintaining forest roads will vary as the new classification system is introduced. Class A roads will always be maintained to a high standard, Class B roads will be maintained only to avoid environmental damage and Class C roads will be maintained to suit their particular usage.

Forest road maintenance needs the same level of planning and co-ordination as other roading operations. Careless maintenance can lead to environmental disasters and extra expense.

The main features of maintenance are to restore the carriageway shape, to keep vegetation under control and to retain the effectiveness of drainage systems. On some roads, these objectives can be met by use of a motor grader. In more difficult conditions an excavator, ideally with a tilting bucket, is needed for ditch clearance and a flail for vegetation control.

It is essential that the reshaped road be compacted as soon as possible. This creates the dense surface that is needed to prevent displacement and water ingress. Compaction is best achieved by use a towed vibrating roller. Machines, such as a JCB 4CX, can be converted to


**Fig. 7 Typical equipment for forest road maintenance**

tow the roller and are ideal in that they can be used for ditch clearance, loading, *etc.*, during non-optimum rolling conditions.

In addition to the general wear and tear, it has to be recognised that for most surfacing materials there will be a loss of fine material through attrition. Forestry Civil Engineering is currently establishing the parameters that lead to this loss. Occasional resurfacing of roads that have worn out, needs to be included in the overall maintenance programme and budget.

## Conclusions

Forest roads have a major impact on both the landscape and efficiency of the forest. Not many of these forest roads in UK are restored after use and therefore become permanent features. Forest engineers have a long-term responsibility to ensure that the design and construction of these roads and bridges are adequate and fit for the purpose intended.

Of equal importance, is the ongoing use of the forest infrastructure. This demands attention to maintaining the assets and certifying the roads and structures for the changing needs and usage of the forest.

Forest engineering is about people and their expertise. Forming partnerships and providing what customers want is the key to success.

Although forest engineers in UK are small players in the world field they can still add to the level of knowledge in this limited area of expertise. Together with my colleagues in FCE, I would value an increased dialogue between practising forest engineers across the world and look forward to this becoming a reality following this Conference.

## Reference

**Hay R, Bell S, Jones B, Killer D, Woodside A, Anstey J, Hampson I, Clough F, Freedman G** (1994). Unsurfaced Roads in the Rural Environment. Institution of Agricultural Engineers. Forest Engineering Group. April 1994.

# BTG sign licence agreement for grain stripper with major South American Company

BTG has signed a third licence agreement for its grain stripper with Carlos Mainero & Cia (Mainero) of Argentina. Under this agreement Mainero has the right to manufacture the stripper header in Argentina and sell products throughout South America. Mainero will also have the right to pursue potential infringements in this region. Other licensees for BTG's successful stripper header are Shelbourne Reynolds Engineering in the UK and AGCO in the US.

The grain stripper is a unique combine harvester header that strips the grain and heads from the straw. It was developed at the Silsoe Research Institute in the UK, an internationally renowned centre of excellence in the application of engineering, sciences to agriculture. Success of the header is well proven with an up to 80% increase in harvesting rates, and reduced grain losses especially where crops are laid or damaged. The grain stripper allows the farmer to harvest earlier in the season and for more hours in the day. In 1990, the stripper set a new world record, which still stands today, for harvesting 54 tonnes of wheat in one hour and has also produced excellent results with barley, oats, linseed and herbage.

Trials at the Rice Research Institute in Louisiana have demonstrated that grain with moisture content of up to 36% can be stripped successfully, enabling harvesting even when the straw is too wet for a conventional harvester. The stripper header is therefore particularly suitable for large scale mechanised harvesting of rice in South America, in addition to the extensive wheat acreage in that region.

Martin Sandford, Director of BTG's Medical & Physical Sciences Division said: 'BTG has supported research and development of the grain stripper over many years and established a wide patent portfolio. Mainero has over 50 years of experience in the design and construction of agricultural machinery and the new licence provides an exciting opportunity to increase manufacture and sales of the grain stripper within South America'.

Contact: **BTG, 10 Fleet Place,**
**Limeburner Lane, London EC4M 7SB**
**Tel: +44 (0)171 575 0010**

# HSE publishes pesticide incidents report 1998/99

The Health and Safety Executive (HSE) inspectors received 150 complaints about pesticide use in the 12 month period 1 April 1998 to 31 March 1999, according to HSE's Pesticides Incident Report for 1998/99 - the lowest number of complaints received since publication of the report began.

Of the 150 complaints, 72 are alleged ill health which was caused by exposure to pesticides from a work activity. HSE's Pesticide Incidents Appraisal Panel (PIAP) has so far considered 31 of these cases together with 53 pending cases from the previous year. PIAP has confirmed links between alleged ill health and pesticides in two of the 84 cases and classified the link as 'likely' in a further 11 cases.

One of the incidents, confirmed as likely, involved 48 members of the public, affected by fumes from an animal repellent applied in an attempt to control an infestation of fleas. The product was not applied in accordance with the conditions of approval, within the ventilation shaft of a local authority managed Day Centre in Wales. The severity of ill-health was classed as moderate.

Commenting on the report, HM Chief Agricultural Inspector, David Mattey said: 'The drop in the overall number of complaints is encouraging. However, as in previous years, the majority of pesticide-related complaints are concerned with crop spraying. The complaints, which are mainly made by members of the public, on investigation, often reveal deficiencies in the provision of information, instruction and training and in the competence of operators.'

Mr Mattey also noted that during the year HSE Inspectors had issued a total of 193 enforcement notices under specific pesticide legislation and that a total of 6 informations had been heard in Court. The average fine on conviction was £930, lower than in 1997/98, but higher than in preceding years.

Revised guidance for sprayers and other users of agricultural pesticides, the '*Code of Practice for the Safe Use of Pesticides on Farms and Holdings*' (The Green Code), was published by the Ministry of Agriculture, Fisheries and Food (MAFF) last year. This free publication provides detailed guidance on good working practice and practical advice on how to comply with the law

Guidance to members of the public on how to report an incident if they think people, animals or the environment have been harmed by exposure to pesticides was revised and reissued earlier this year. A free leaflet is available from HSE: '*Reporting incidents of exposure to pesticides and veterinary medicines*' [INDG141 (rev1)].

Contacts: Enquiries about the *Pesticide Incidents Report* and requests for free copies should be addressed to the **Health and Safety Executive, Agriculture and Wood Sector, The Pearson Building, 55 Upper Parliament Street, Nottingham NGI 6AU Tel: 0115 971 2800).** *'The Green Code'* is available from **MAFF Publications, ADMAIL 6000, London SW1A 2XX. Tel: 0645 556000).** For the *INDG141 (rev1)* contact the **HSE Infoline Tel: 0541 545500.**

# 'Check your farm for old dip' warns HSE

The Health and Safety Executive (HSE) urges farmers to check that any chemicals in store, particularly animal medicines, are within their expiry date. If not, using them can involve a high risk to people and livestock.

An HSE investigation into a reported case of ill health revealed that an out-of-date organophosphorus (OP) sheep dip had been used. The investigation highlighted the increased risks from using out-of-date chemicals. For example, some OP dips break down to compounds which are more hazardous than the original product. This is especially so when the container has been opened and exposed to moisture.

Allan Spence of HSE's Agriculture & Wood Sector warned: 'While farmers may think that out-of-date chemicals lose strength, the opposite is sometimes true. Some OP dips can become far more poisonous and they should never be used after the expiry date.'

Contacts: **Call HSE's InfoLine, Tel: 0541 545500, or write to: HSE Information Centre, Broad Lane, Sheffield, S3 7HQ.** For advice on safe disposal of out-of-date farm chemicals, farmers should contact the Environment Agency on 0645 333111 (or local Scottish Environment Protection Agency (SEPA) offices in Scotland).

# Prospects for the harwarder

## -The combined harvester/forwarder

**Ulf Hallonborg**

***This paper was presented at the 1st International Conference on Forestry Engineering entitled: 'Forestry Engineering for Tomorrow', organised by the Forestry Engineering Group of the IAgrE and held at the University of Edinburgh, Scotland, UK on 28-30 June, 1999.***

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### Introduction

It is no coincidence that single-grip-harvester (SGH) systems have become so competitive in shortwood (or cut-to-length) systems. In many previous systems, the aim was to limb and buck (crosscut) the wood automatically, in parallel with felling controlled by the operator—which was also the basic concept of the two-grip harvester (TGH). When the TGH concept was introduced, the reliability of the automatic process was unsatisfactory and the operator became accustomed to intervening in the automatic process as well. Such habits tend to persist even when there is no longer any real need for intervention. The absence of processes that could operate in parallel was a big drawback for the TGH. When the SGH was introduced, operations such as felling and limbing were executed in sequence as on the TGH. On the SGH, however, because the same device effected all the operations, the operator could concentrate on that all the time. Further development of the method led to a substantial overlapping of operations. Thus, the tree is retracted and limbing started before the stem has fallen. Overlapping operations are crucial to the competitiveness of these systems. Having scrutinised possible systems, several of which have been tried and not found worthy of further development, we found that SGH systems seem to be superior and that further development of them is well worth considering (Hallonborg, 1998a and 1999).

## Birth of the harwarder

Regardless of what different harvesters are called, the way in which they all work results in piles of wood being left on the ground, with the logs more or less sorted and aligned. Sometime later, the forwarder operator comes along and starts looking for specific piles to load. It seems logical here to extend the concept of overlapping operations to the loading as well—which is where the harwarder, a combined harvester and forwarder, comes in.

What made the harwarder an attractive option right from the start was the saving that could be made from having just one machine to move from site to site. The saving per cubic metre, however, falls sharply with an increase in the area of the stand, which means that the reduction in cost only pays off on small sites.

During the development of the SGH, different harwarder concepts, such as interchanging between harvester head and grapple, adding grapple arms to the harvester head and using manually retractable feed rollers were also tested. Yet, because the competitiveness of the harwarder system still hinged on the lower moving cost, the harwarder remained a niche machine for small sites.

In the late nineties, a new type of harwarder head was developed both in Sweden and Finland. It was based on a grapple-like construction with integral feed rollers, chainsaw and limbing knives and this type of head offered true flexibility, enabling the machine to switch between harvesting and loading at any time, without the need for any conversion work. This flexibility opened the door to methods development that led to the commercial introduction of the harwarder concept in thinning.

## State of the art

*Equipment*

Today, there are at least three manufacturers of commercially available harwarder heads: P-O Gunnarsson and Hemek AB in Sweden, and S Pinomäki KY in Finland. The Swedish versions, called Pogen and Wood King Duo, respectively, were developed from the same basic concept.

In Sweden, harwarder devices have been mounted on two Hemek, one Timberjack and one Logset forwarder. In addition, in Finland, two Valmet 838 Combi tree-section turntable harvesters have been converted into harwarders. In all, six machines are equipped with harwarder devices; Pinomäki has three models, the Pika 300, 400 and 500, which correspond to three different maximum limbing diameters. The first version of the Pika 300, which is intended for use in thinning, was introduced on the Pinomäki 728T forwarder and was followed by the Combi Trac models with 400 *(Title Figure)*, and 500 heads. Ten to twelve units of the 300 model have now been mounted on various forwarders, all in Finland. Two of the larger models, which are equipped with turntable loader and cab, have been delivered to Germany or Austria. One third remains in Finland.

In Finland there are also two other prototypes, one built by Nisula on a converted Valmet 838 and another by Moisio on a conventional Valmet 840 forwarder. Thus, there are some 20 harwarders in operation today.

*Methods*

The dominating method followed by the first harwarders was to open up the striproad and place the wood in piles alongside it. Next, selective thinning alongside the striproad was carried out, whenever possible placing the wood on the existing piles and loading it immediately. Depending on the machine and the planning of the site there are variations in the method, but generally some time is gained through less driving in the stand and less loader manipulation. Stanchions or stakes that are adjustable in height make the loader work easier and loading possible even when opening up the strip road.

*Performance*

SkogForsk has performed a theoretical analysis of the harwarder system and presented the findings at the Research & Development Conference in Sweden in early 1998 (Hallonborg, 1998b and 1998c). The analysis was in the form of a comparison between a conventional two-machine system and a harwarder system. The model allowed calculation of the site area at which there was parity between the two systems, based on the stand density, stem volume, number of assortments and several other variables.

The parity points from Table 1 form a pattern of intersections between the curves denoting stem volume and those denoting number of assortments. The site area at which there is parity between the systems decreases rapidly with stem

**Table 1 Data obtaining when the harwarder is on a par with a two-machine system.**

| Logging type | *First thinning* | *Second thinning* | *Final felling* |
|---|---|---|---|
| Stem volume, $m^3$ | 0.06 | 0.20 | 0.40 |
| Stand density, stems/ha | 2300 | 800 | 600 |
| Extracted volume, $m^3$/ha | 50 | 50 | 250 |
| No. of assortments | 2 | 3 | 4 |
| Site area at which parity obtains, ha | 5 | 1.5 | 0.8 |
| Cost at parity level, Skr/$m^3$ | 170 | 135 | 65 |

**Table 2 Cost comparison between the results of the study by Cederlöf (1997) and those of the model for a site area of 2.5 ha; SGH, single-grip-harvester.**

| *System* | *Cost for 2.5 ha, Skr/m³* | |
|---|---|---|
| | *Study* | *Model* |
| SGH + forwarder | 109 | 111 |
| Harwarder | 97 | 111 |

volume and number of assortments.

Over the past two years time studies of harwarder systems have been performed by other bodies than SkogForsk including our Finnish counterpart Metsäteho. The findings are reviewed briefly below, together with results obtained from the above model using input data from each study.

Cederlöf (1997) studied the original Pogen harwarder device with Keto track feeding. The site was a second thinning and the original striproads were used. The stand density was 1000 stems/ha, the stem volume 0.25 m³, and the extracted volume 51 m³/ha in four assortments. The results of the study and a comparison with the above model are shown in Table 2.

The model shows parity at 2.5 ha at a cost of Skr 111/m³. The study returned a similar cost but the cost curves fail to intersect. It should be emphasized that the angle between the cost curves is small and the result is therefore highly sensitive to the input data.

Hellgren (1997) used simulation to study differences between the two systems in loader manipulation and driving on the site in thinning. He found that:

- the distance that the boom tip was moved was reduced by 22% when using a harwarder in first thinning;
- in second thinnings, where existing striproads could be used, boom-tip movement was reduced by 36%; and
- the number of passes at a specific point could be reduced by 50% when a harwarder was used.

The logging cost for the two-machine system was calculated according to the same norm as that used by Cederlöf. For the harwarder system, he used the cost derived from the study by Lilleberg (1997), Table 3, on the Pika 300 in Finland. Table 3 gives the results compared with our model. The costs refer to a site with a mean stem volume of 0.10 m³ and a density of 1300 stems/ha. The extracted volume was 47 m³/ha.

**Table 3 Comparison between the results of the study by Hellgren (1997) with those of the model for a site area of 3.1 ha; SGH, single-grip-harvester; PMH, productive machine hour**

| *System* | *Cost for 3.1 ha, Skr/m³* | |
|---|---|---|
| | *Study* | *Model* |
| SGH + forwarder | 128 | 139 |
| Harwarder at Skr 520/PMH | 112 | 112 |
| Harwarder at Skr 660/PMH | - | 139 |

At the lower hourly cost for the harwarder, no parity level is obtained in either Hellgren's study or the model. At the same cost per productive machine hour (PMH) for the harwarder as in Cederlöf study, *i.e.*, Skr 660/PMH, the model indicates parity at Skr 139/m³ for a site area of 3.1 ha.

Lilleberg (1997) made an economic comparison between the two types of system. Even though the input data were chosen to favour the two-machine system, parity between the two systems was reached at a stem size of 0.15 m³.

*Model validity*

There is fairly good correspondence between the results that the model gives and the study results. The verified model can thus be used to study the included variables in more detail. Taken together, the findings indicate that the harwarder system is competitive under the following conditions:

- small sites—lower cost of moving between sites;
- low stem volume—increases the proportion of time accounted for by harvesting;
- few assortments—resulting in fewer piles and less loader manipulation; and
- short main haul roads—reduces the proportion of time accounted for by haulage.

Of course, these conditions do not all have to be met on the same site; it is more a question of striking a balance between them. In general, anything that reduces the time taken in forwarding adds to the value of the harwarder, which is, after all, a rather expensive forwarder. It is also important to remember that the investment cost of the harwarder is only a part of the hourly cost. The cost for maintenance and wear is not the same for the systems. For example, one harwarder head may last the entire lifetime of the harwarder, as compared with the two heads usually needed during the life of a harvester.

The conclusion is that harwarders that load all wood from piles on the ground are competitive against the usual two-machine system only in limited circumstances. Such harwarder systems rely heavily on the reduction in the moving costs and therefore need a market in which there is a high enough proportion of suitable sites.

## The next step

It is evident that the economy of a harwarder system depends heavily on the proportion of suitable sites in the area in which the system is to operate. Reducing the moving cost is not sufficient, especially if the harwarder head has a somewhat lower capacity in harvesting and/or loading. Something more has to be done with the system to make it competitive regardless of the moving cost.

I mentioned earlier that the efficiency of the single-grip harvester depends upon its capability to perform overlapping operations. In a harwarder system this principle could be extended to include loading of the wood, whereby the logs are processed straight onto the load.

Lilleberg (1997) performed a study of the Pika 300 harwarder in a first thinning. For the harwarder, the mean stem size was 0.08 m³ and the stand density 1500 stems/ha. The study showed that 88% of the total effective machine time was used for cutting and forwarding, and that there was close to a 50-50 relationship between cutting and forwarding. To be more exact, 40% of the total time was accounted for by forwarding. Of this 40%, loading the harwarder accounted for 25 percentage points. Thus, if all loading could be eliminated there would be substantial potential for reducing the logging cost.

*Integrated loading*

At least four ways to achieve integrated loading, *i.e.*, the loading of some proportion of the processed logs straight onto the harwarder, have been discussed:

- loading from the rear;
- loading from the rear or front onto a turntable load deck;
- loading from the rear or front into a transverse load space; and
- loading from the rear into one of two load spaces.

***Fig. 1 Sydved's harwarder function prototype for testing integrated loading and handling of standing trees.***

The first method, processing from the rear and discharging the logs into the load space, is the simplest method, which can be used, for the striproad trees with only minor modification to the existing harwarders. With height-adjustable rear stanchions, the method can even be applied to trees adjacent to the striproad. The tops would then be felled into the striproad and the butt ends would be lifted in over the lowered stanchions. This method has been tested and studied by MoDo Skog. Ahlenius (Anon, 1998) found that productivity in opening-up of the striproad rose from 7.6 to 8.6 $m^3$/PMH when the trees were processed and loaded in one operation. Although this 13.5% rise in productivity suggests that about half of the potential cost saving mentioned above could be realized.

The most obvious drawback of this method and of integrated loading, as a whole is that mixed-assortment loads are produced unless action is taken to separate them. However, if intermediate stanchions are used, two or even three assortments can be handled. If a larger number of assortments need to be handled, it would probably be expedient to load some of the assortments separately, rather than in conjunction with processing.

Another drawback with integrated loading is that the operator's view becomes restricted when the load exceeds about half its final height. Use of a raised cab, such as the Pendo cab, could partly overcome this problem.

Ahlenius (Anon., 1998) also compared integrated loading of pulpwood alone (from the striproad) with integrated loading of mixed assortments. He found that productivity in handling the pulpwood alone, with the two sawlog assortments being loaded separately from piles on the ground, was 4.5% higher. Integrated loading of mixed assortments required time-consuming sorting to be carried out at the roadside, although Ahlenius notes that the use of intermediate stanchions could have reduced this time.

The second method, that of using a turntable load deck that facilitates integrated loading both from front and rear, affords better visibility for the operator during processing. The load space can also be adjusted to suit the lie of the trees felled between the striproads. Moreover, in this method the butt ends do not have to be oriented in the same direction.

The third method is similar to the second but is achieved in a technically different way. Because the machine has two steering joints, it is possible to position the machine in a 'Z' shape, making the load section accessible for loading from both front and rear with logs that are aligned parallel, or at a slight angle, to the striproad. The second and third methods might need more space than the striproad allows, and might therefore be most appropriate for use in final felling. The principle on which the method is based has not been tested in practice.

The fourth method, whereby the load is split into two sections, is of particular interest in southern Sweden, where pulpwood is often bucked (crosscut) to standard 3 m lengths. The reduced height of the load increases operator visibility and allows a higher proportion of integrated loading—the two load sections facilitating the handling of assortments. Additional wood can also be loaded onto the back of the machine as it heads off along the striproad towards the landing, since visibility is no longer a problem. The upshot is that the payload carried by a dual-load harwarder can be as much as 50% greater.

*Handling standing trees*

As we have seen, integrated loading is largely confined to the striproad trees, which means that, in thinning, half or more of the processed volume is bunched in piles on the ground pending subsequent loading. The obvious way to make integrated loading possible in conjunction with the selective felling between the striproads is to handle these trees upright, lifting them onto the striproad, processing them horizontally and discharging the pulpwood bolts straight onto the harwarder. In theory we could achieve 100% integrated loading if the sight problem is dealt with as suggested above.

An important advantage of processing all trees in the striproad is less damage to standing trees. The most common and severe damage in a harvester system is that the butt end of processed tree hits another stem, especially if the trees are processed across the strip road to get all the brush there.

*Function prototype*

To test the feasibility of integrated loading in conjunction with handling of standing trees a company, Sydved AB, in Southern

**Table 4 Results from a time study of the Harwarder function prototype and conventional single-grip-harvester (SGH).**

| Result | Capacity, m³/effective machine hour at roadside | | |
|---|---|---|---|
| | Harwarder function prototype | | Conventional |
| | Spruce | Pine | SGH, pine |
| Original | 3.9 | 4.1 | 4.5 |
| Recalculated | 5.1 | 5.3 | 4.5 |

Sweden initiated the build up of a function prototype, with technical support from Valmet, consisting of existing components. A Valmet 901 SGH was equipped with a Pogen harwarder head completed with two grapple arms to be able to handle standing trees. The loading space was simulated by a carriage that was pushed in front of the machine *(Fig. 1)*.

SkogForsk has carried out time studies on this function prototype used as harwarder in both a pine and a spruce stand with mean stem volume 0.05 $m^3$ under bark. All trees beside the strip road were handled standing. The results were expressed as $m^3$ at roadside per effective machine hour. In addition the function prototype was used as harvester without the carriage in order to establish the technical level of the harwarder technique compared to a conventional harvester also studied in the same stand. The results are shown as the original capacity in *Table 4*.

In a later study of the Pika 400 Combi Trac that remained in Sweden some time after the Elmia exhibition we carried out a study on this technique used as pure SGH in a similar pine stand as above. From that study, we could conclude that there are harwarder heads that can fully cope with harvester heads in harvesting. We can therefore allow recalculation of the study results with the capacity of the for the harvesting time raised in proportion to the difference, in the first study, between the harwarder used as harvester and the conventional harvester. The last row in Table 4 shows the recalculated capacity.

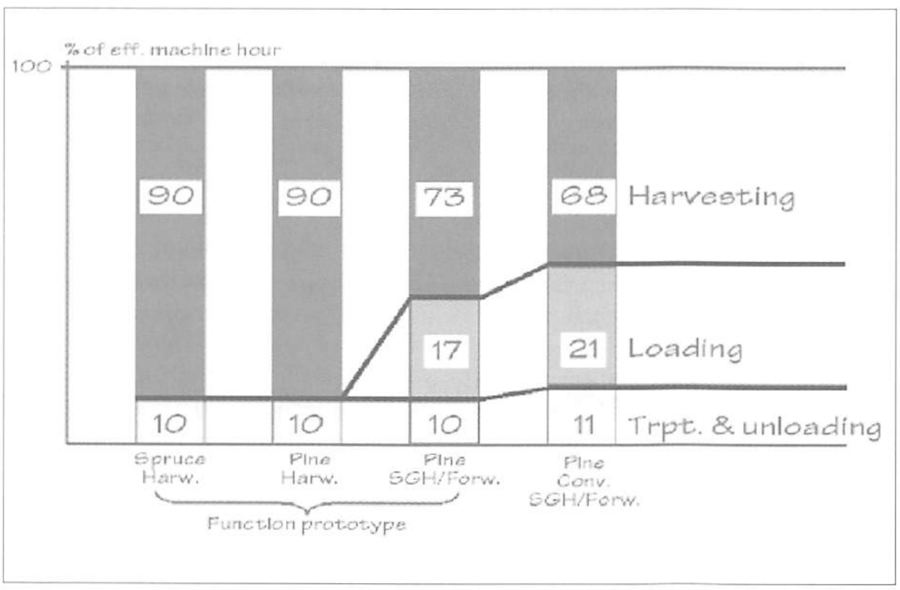


***Fig. 2 Time distribution for the studied systems.***

## Harwarder potential

There is obviously a close interaction between the machine configuration, the site conditions and the best method to be applied. A good deal of work remains to be done before the harwarder technique and methods can be regarded as fully satisfactory. The figures in Table 4 show that the harwarder system is on a par with the two-machine system when the same technique is used for harvesting. When the harwarder head has got full capacity in harvesting, the harwarder system beats the two-machine system by half a cubic metre. The cause is revealed if we look at the time distribution in the different studies *(Fig. 2)*.

The two bars to the right show that in the harvester systems about 70% of the time are used for harvesting and 10% for transport and unloading. But as much as 20% is used for loading the forwarder. In the harwarder system, this 20% has vanished into harvesting time. Thus we can use 20% of the effective time to compensate for a more expensive forwarder and if necessary for a somewhat poorer harvester.

In the calculations, all loading is supposed to be integrated, which may not be possible, especially if several assortments are used. But on the other hand no benefit from the reduced moving cost is included and all trees have handed single. Multi-tree handling can give a significant raise to the capacity.

Altogether the harwarder system seem to have a fair chance to compete with the conventional system, and even beat it, when technical and methods development have used up the harwarder potential.

As well as the easily quantifiable properties, the harwarder system also includes several properties that so far can only be regarded as qualitative. Some of these properties are listed below, based on my own subjective opinion of whether they are pros or cons of the harwarder system.

*Pros*
More fresh wood
Less wood stored on the site
Less contamination of the wood
Easier planning
Less sensitive to disruption
Less ground damage
Greater job rotation

*Cons*
Restricted to striproads
Only one man on site

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# Permethrin dipping of forest plants banned

The Pesticides Safety Directorate (PSD) has revoked the off-label approvals for dipping forest transplants with permethrin-based insecticide because commercial approval is now available for an alternative method. The revocation will take effect from 30 June 2000.

The PSD has granted commercial approval to a new, oil-based formulation of permethrin that can be used with the 'electrodyn' system of application. The electrodyn system is an electromechanical one that works by spraying plants on a conveyor belt with a quick-drying, solvent-based, electrically charged formulation. An electrical charge on the spray droplets means that they are attracted directly onto the plants, enabling precise targeting of the insecticide. The enclosed nature of the process reduces the risk of operator exposure.

Off-label approvals for use of aqueous-based formulations of permethrin as a spray after planting, or as a spray treatment for container-grown seedlings in nurseries, are unaffected.

'The granting of commercial approval to a product that can be used with the electrodyn system means there is no longer any justification for continuing to use dipping,' the Forestry Commission's Head of Policy and Practice, Paul Hill-Tout, explained.

Until recently, dipping in insecticide was the only established method of protecting young trees against attack by *Hylobius abietis* (large pine weevils) and *Hylastes* beetles, which inflict severe damage by feeding on the bark. Without such protection, losses on some conifer restocking sites can reach 100 per cent, and it is estimated that average losses across the country would be 50 per cent.

Dipping in permethrin is an effective method of treating plants but relies on Personal Protective Equipment (PPE) to prevent exposure of operators to the pesticide. Even with rigorous measures for protective clothing and health monitoring in force, dipping is an undesirable methodology when practicable and effective alternatives exist.

Although the electrodyn process has already been widely used by the Forestry Commission on an experimental basis, it is recognised that there might in the short term be problems in the supply of machines to the nursery industry and in the supply of suitable formulations of insecticide to use in them. In view of the crucial importance to British forestry of effective treatment against *Hylobius* and *Hylastes,* the Commission and the PSD will continue to liaise closely over the situation.

'Permethrin is being reviewed under the European Plant Protection Products Directive,' Mr Hill-Tout said. 'It has not so far been supported in the review by any of the manufacturers, so its long-term future availability as an approved pesticide in any formulation remains in doubt.'

'For this reason the Forestry Commission will continue to seek alternative control measures as an insurance against the possible withdrawal of permethrin. One of the measures under investigation includes the use of microscopic worms known as nematodes as a form of biological control.'

'The research programme will also examine other mechanically assisted treatment methods, and further work on the electrodyn system itself with a view to enabling its use with insecticides other than permethrin.'

Contact: **Dr Steve Gregory, Forestry Commission Policy and Practice Division, Tel: 0131 314 6392 (direct), 0131 334 0303 (switchboard), e-mail:steve.gregory@forestry.gov.uk; or Stuart Heritage, Forest Research, 0131 445 6925 (direct), 0131 445 2176 (switchboard), e-mail: stuart.heritage@forestry.gov.uk**

# *Membership* Matters

**Quarterly** The Newsletter of the Institution of Agricultural Engineers **Winter 1999**

# Horticultural Engineering Specialist Group Humberside visit

**Manus de Lang discussing the finer points of tomato crop management at Mill Nurseries with some of the Group**

Both from the Netherlands, Gerrit de Lang and Joe Overvoorde settled in East Yorkshire around 1960. Commercial horticulture at this time in Britain was in the doldrums but they perceived the potential longer-term opportunities open to them by setting up in as growers on North Humberside: a major step to take under any circumstance but both possessed a strong sense of business and the essential determination to succeed. They established two very different nursery enterprises which have grown organically (in a purely economic sense) to become major family business concerns, now largely in the hands of their second generation, and well known to the industry. Both these enterprises have achieved this with outstanding success and, undoubtedly, one of the key factors has been their ongoing investment in state-of-the-art engineering technology and it was this latter point that led to our choice of this particular theme for the Group's most recent technical visit.

## Mill Nurseries

Our day commenced at Mill Nurseries, Keyingham; a 6.8 ha modem glasshouse unit devoted entirely to long-season tomato production (supplying the domestic market mainly through Safeway, Asda and Tesco), managed by Gerrit's sons David, Manus and Rob. The glasshouses are of the latest Venlo (high light transmission) type with a 4 m eaves internal clearance; providing the necessary headroom for the high-training method of tomato plant suspension, thermal screens and overhead irrigation lines. The integrated heating, ventilation and atmospheric $CO_2$ enrichment system is fully computer-controlled. A modern, central natural-gas fired boiler unit supplies the glasshouse space heating via a high-speed piped hot water system: $CO_2$ is taken directly from the boiler flue gas for atmospheric enrichment. The whole crop (a total of 230 000 tomato plants) is grown hydroponically on rockwool in a closed-cycle irrigation system with automatic pH and conductivity (fertiliser status) control. The local water main supply is expensive, currently at 75p/m$^3$, and their clay-lined lagoon, with a capacity of 45 million litres, supplied by rainwater collected from the glasshouse roofing (at nearly 7 ha, a significant catchment area!) has proved to be a valuable cost-cutting investment. Being virtually de-ionized, rainwater is ideal for use in a hydroponic system.

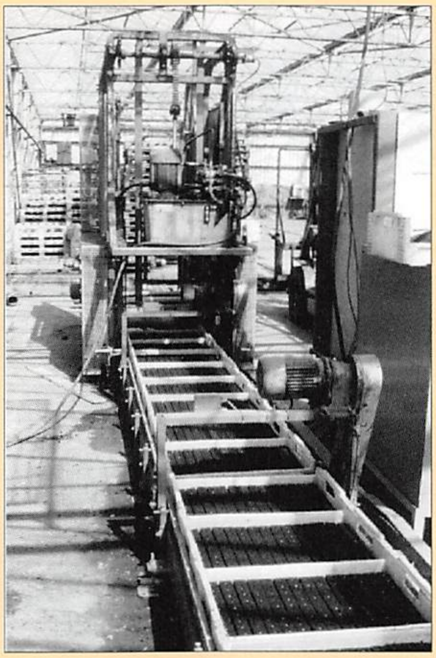
Labour is potentially the largest single item in the direct costs of tomato production and mechanisation of materials handling to improve labour productivity continues to be a priority forgrowers in this sector. Mill Nurseries have been no exception in this respect, with an ongoing programme of investment aimed at cutting labour costs while maintaining and, whenever possible, improving crop management,

**The manual input to an otherwise fully automated tomato grading line**

harvesting and grading. Undoubtedly, equipment such as battery-electric motorised working platforms running on the heating pipework has achieved significant improvements in labour productivity; while in, conjunction with this, a microprocessor data recording and retrieval system installed in each of the greenhouse working sectors, networked with the central computer unit, has substantially improved day-to-day supervision and crop management with a glasshouse labour force now down to 5/ha.

By far the most significant recent advance in engineering technology associated with tomato production has been the development of automated produce grading (colour, size and weight recognition) equipment. This greatly reduces labour input while eliminating much of the human error factor - a major problem in such a highly repetitive process. With an annual total of 3600 tonnes of harvested tomatoes to be graded individually (by size, colour and weight) into 6 kg capacity boxes, one can visualise the magnitude of this task. The recent substantial investment in one of the latest Aweta automated tomato grading lines, capable of grading 6 tonnes of tomatoes per hour, is a crop-handling feature essential for meeting the exacting standards of their supermarket customers.

The most recent development at Mill Nurseries has been the installation of the first phase (7.5 MW) of a 15 MW combined-heat-and-power (CIAP) system; owned and installed by Nedalo (UK) Ltd. On the occasion of our visit, construction work for the initial phase was at an advanced stage and we were left in no doubt as to the magnitude of the project. In recent years, our protected cropping industry has benefited from the general downward pressure on fuel prices: the extension of the national gas pipeline infrastructure throughout the UK, bringing natural gas to most of our larger growers, has also played a significant part in this. With signs of a hardening of world oil prices - bound to have a knock-on affect with energy prices in general together with the ominous threat of an energy tax, tomato grower's production costs could be significantly increased. Looking to the future, Mill Nurseries have taken the step of providing Nedalo, one of our new businesses in commercial electricity generation, with a secure site together with natural gas supply laid on in return for a free supply



**One of three conveyor lines at Premier Plant Producers; part of a continuous, almost completely automated, process from bulk compost store to single-seeded modules (140) per tray, carrying trays to be stacked automatically for loading onto the transfer shuttle**

of heat (rejected in the generation process)- in this particular case sufficient to supply approximately double their present maximum heating demand - and $C0_2$ (cf Geoffrey Lawson, Landwards, Vol. 54, No. 1 Spring 1999, pp. 10- 12).

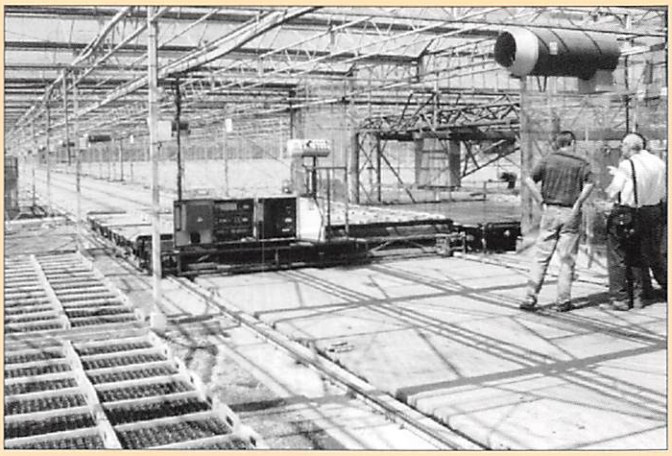
## Premier Plant Producers

Our afternoon visit took us to a very different nursery enterprise less than a mile away on the other side of Keyingham. The name of Premier Plant Producers has been well known to growers throughout Britain for more than 25 years. Recognising the move to increased specialisation within the commercial horticultural industry and the opportunities this offered, in the mid 1970s Joe Overvoorde moved into the business of supplying growers with young plants grown in peat-based modules. Today, under the direction of his son Peter, Premier Plant Producer's production target runs at between 180 - 200 million plants annually: their market being growers of salad crops (lettuce, tomato and celery), outdoor vegetables (brassicas) and cut flowers.

All the plants produced are grown from seed, sown by an automated process into individual modules contained in purpose-designed plastic trays, each containing 140 modules amounting to a total of approximately 8 kg of substrate material. Germination and the growing on to the right stage for dispatch is a strictly controlled operation taking place mainly under glass. Batches of plants are delivered to grower customers by container vehicles throughout Britain. Producing, handling and dispatching 1.3 million trays of young plants annually in good health and on time (to within a day or so) is a daunting logistical operation and can only be achieved successfully with the combined application of computer-based scheduling, mechanisation/automation and (most of all) enlightened management.

Growing and managing on a day-to-day basis not only this quantity of plants but also the range of species is an exacting task in itself. Just as great, however, is the magnitude of the handling process involved. The following sequence of events are typical of a handling cycle for each tray: removed from the initial stacking store; filling with peat modules; sowing with pelleted seed (normally one per module) and initial watering; positioning in an area allocated for germination and growing on; removal (now containing young plants) to be stacked into batches at the dispatch collection point for loading onto vehicles for delivery to growers; unloading of returned trays which are washed, sterilised and returned to the stacking store. In the average working week at least 100 000 individual tray movements are made and without the use of three items of specialist equipment in their latest 3.6 ha propagation area, this whole operating cycle would be uneconomically labour-intensive.

The first of these is the compost handling, tray filling and sowing unit. This consists of three continuous, automated operations which start at the compost bunker from which the compost is transferred by conveyor to an automated tray filler. The trays, now charged with compost, then go through a fully automated sowing and watering process at the end of which they are mechanically stacked in readiness for moving to their positions in the growing area. This whole operation (divided into three production lines) and supervised by two operatives is capable of turning out 750 trays (105 000 seeded modules) per hour!

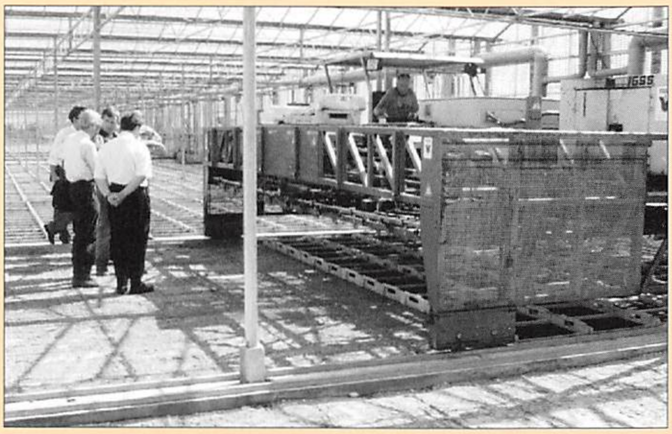


**Peter Overvoode demonstrating the transfer shuttle, with its load of 91 trays, travelling along the central 'clearway' towards its destination opposite the transporter gantry (extreme LHS of picture)**

The transfer of seeded trays to the growing area involves the second item of equipment. Basically a shuttle, this mobile platform carries a batch of 91 trays very precisely positioned on its deck enabling a robotic removal process. Destacking and loading the trays onto the shuttle is a fully-automated conveying operation The electrically-driven shuttle travels on track laid in a 'clearway' running up the centre of the house delivering its batch of trays to points at which the tray-lifting gantry can remove its contents.

A tray-lifting travelling gantry, the third item of equipment, travels on a 'herring bone' complex of track, running at right angles to the central clearway, covering the entire 3.6ha area. The gantry's primary power unit is an IC (diesel engine) which transfers its power via a mixed electrical/hydraulics system to its various operating components. Driven over the shuttle, it can remove the entire contents (91trays) from the shuttle deck in one lift, transporting them to any point within the propagation area. The actual lifting operation is achieved by 7 banks of hooks simultaneously raising or lowering the trays as required. A further task for the shuttle is that of transferring the gantry, pickaback fashion, to a fresh track either to set down or to remove trays.

This central blocking, sowing and transporting system comprises the key part of a fully integrated materials-handling cycle, much of which has been purpose-built to match Premier Plant Producers' specific requirements. As Peter Overvoorde commented: this major investment in mechanising and automating what is essentially a handling process has roughly doubled labour productivity but, in doing so, demands an entirely different class of person to make it work successfully. Such personnel are not so easy to find!



**A batch of trays lowered into their final position beneath the gantry**

## Engineering technology's pay-off

It was very clear on our tour of both nurseries that we were not witnessing a series of technological extravaganzas but, in reality, shrewd investments made as hard-headed business decisions; key factors ensuring survival and expansion in a highly competitive market. Our Group extends its sincere thanks to Manus and Rob de Lang at Mill Nurseries and Peter Overvoorde at Premier Plant Producers who afforded so much of their time to tell us how all this has been achieved.

*John Weir*

# Letter to the Editor

2 September 1999

Dear Sir,

**Skills Training**

I read your article in Landwards on the subject with interest and in general fully subscribe to your view. I would like to offer my comments on two points.

Firstly, for the type of Engineering Technician we need, we find that an HND or Degree level graduate is the right level but that sound practical experience and preferably a farming-family background is essential. Without this, the actual college work and qualifications is not sufficient to provide a practical view to field situations and to be able to communicate with farmers and dealers. To ensure we obtain the best people that are right for us, we have for many years been committed to an extensive work placement programme with Agricultural Engineering students from Harper, Silsoe, Writtle and some others. This has proven to be very successful as a long term interview process and we have employed many former work placements once qualified.

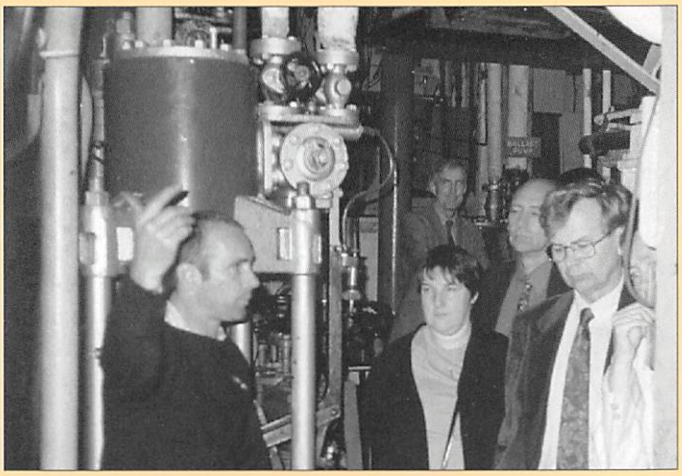
As far as Skills Training for our dealer technicians are concerned, we found many years ago that the level of skills training provided by many of the block release colleges was woefully out of date (Fordson Major engines, etc.), that technicians once qualified had to be retrained to modern technology and that retention rates were very low due to no brand loyalty. Since 1992, we have operated our John Deere Ag Tech programme which very successfully solves all three of these issues and is considered by our dealers to be invaluable in developing technicians of the future. Since its inception, we have recruited 158 apprentices into this programme and have an 82% retention rate.

If you would like further information on any of these activities, or would like to visit the new state of the art Training Centre, please phone 01949 860490.

Yours faithfully

**P N Leech** AMIAgrE
John Deere Ltd, Langar
Nottingham, NG13 9HT

# Southern Branch goes on a nautical visit



**Aboard the S S Shieldhall**

Earlier this year, on a Sunday towards the end of June, a small party of engineers from the Southern Branch, many of them together with their wives and families, gathered at Portsmouth's roll-on, roll-off, ferry terminal for what was to prove an exceptional day out. The day's activities were subsequently recorded by many as probably the best combined technical and social visit that the Branch had enjoyed, within their memories.

The party gathered at 10.15am at the cross channel terminal dock gates for the first port of call which was to a modern roll-on roll-off ferry that plies regularly between Southampton, Channel Islands and St Malo. Split in to two groups, we then undertook a tour of the engineering features of the ship, which was enjoying a few hours off from its otherwise remorseless 24 hour schedule, to effect a crew change.

Many will have journeyed on cross channel ferries but to see what lies behind those closed bulkhead doors was quite fascinating. Commodore Ferries, who owned this particular ship, operate a fleet of modern vessels of which the one we were visiting MV Island Commodore was amongst their newest. A good link with agriculture was effected when we learnt that the boat had been heavily involved, for the last couple of months, in the shipment of Jersey Royals new potatoes, back to this country.

The crew complement was 19 persons. All the officers were British, working a roster of 14 days on and 14 days off. The remaining crew was Polish and for them, the vessel was their only home for their more extended period of duty.

The tour was strongly engineering orientated and we were able to see and learn about the two main propulsion units each developing 4500 kW at 500 rpm. These were MAK four stroke, turbo charged, intercooled, medium speed, non-reversing marine diesel engines. Speed and the forward or reverse direction of the vessel was controlled not by engine revolutions but by varying the pitch of the propellers, which were 4 metres in diameter and ran at 145 rpm. Two 590 kW electrical bow thrusters aided manoeuvring in harbour and the rudder could be hydraulically 'bent' to achieve truly lateral movement in the water.

Particularly interesting to see, was the on board sewage works. This ship puts nothing whatsoever over the side, out of harbour. It was also surprising to hear the Chief Engineer's low opinion of the German machinery because of its poor reliability and to learn that gradually it was all being replaced with British designed and built equipment. Auxiliaries were all electrically operated and to drive these diverse loads there were two diesel driven 755 kW generators and two similar power take off driven generators. One of the interesting functions of these was to pump sea water between either side of the double skinned ship to stabilise it when being loaded.

After a concluding visit to the bridge and the crew's quarters we had to hurry back to the cars and make the short journey to Southampton where we were to have lunch on a very different sort of boat. The SS Shieldhall is the UK's largest operational steam driven preserved cargo and passenger vessel afloat. Built not so long ago in the 1950's on the Clyde this vessel is equipped with triple expansion Lobnitz steam engines for propulsion and numerous auxiliary drives. Latterly it had been used by Southern Water to dump sewage waste at sea whilst at the same time offering short sea trips to passengers in quite opulent surroundings! As can be imagined the contrast between the two ships could not be more marked.

A really excellent lunch was taken with the help of an on board bar. From the Shieldhall, it was on yet again for a high-tech visit the Harbour Control Tower and then to watch the final preparations for the sailing and departure of the Queen Elizabeth II. Last minute passengers, crew and baggage, we watched it all, including the quay side band. The last spectacle of the day was the arrival of the Orient Express train with its contingent of what appeared to be wealthy or VIP passengers. The truly opulent carriages and dining car gave a taste of how some live. Not too many agricultural engineers we felt were numbered amongst these passengers!

This action filled day was really appreciated by everyone especially by the children present. The Branch is extremely grateful to one of its members David Kane who was able to arrange the whole package by virtue of the contacts that he makes through his business of providing repair and maintenance engineering within the dockyards.

*O J H Statham,*
*Branch Honorary Secretary*

# Pioneering Technology Specialist Group summer meeting

It was a lovely warm day to match the warm welcome on the Pioneering Technolgy Specialist Group visit to Silsoe Research Institute on Saturday 10 July 1999. Twenty enthusiasts came, some from as far as Worcestershire and Lincolnshire, including one in his 1937 Wolsley.

Professor Bill Day gave us an overview of the work of SRI as an introduction. We appreciated the preparation which had been done prior to our visit which included Paul Miller showing the development of spraying from horse drawn sprayers through the various stages to their state of the art wind tunnel and droplet monitoring equipment.

Andy Scarlett brought in an old tractor, a Ferguson TE 20 to illustrate how, in the early days, it was possible to use mechanical control on tillage equipment and how with the developments of much bigger and higher horse-power equipment it was no longer possible. The electronic control he was working on had now become necessary.

After the lunch break Brian Palmer, a speaker from English Heritage, told us a little about the history of Wrest Park. This was an excellent start to adventure around the extensive grounds now in their care.

Thanks must be extended to Edwina Holden for all the work in organising the day and to the Director of Silsoe Reseach Institute Professor Brian Legg. An excellent day with one group from our party still having a picnic in the shade of a tree at 5.00pm

In addition to technical meetings through the year, the group's next planned summer visit is to a behind-the-scenes look at one of the major development sites of the early industrial era at Ironbridge on 10 June 2000. Look forward to seeing you there.

*William Waddilove*

## CAREERS information

Promote our industry as a career path worthy of consideration. What are job prospects in agricultural engineering? What are the routes to success? Where are the Colleges and Universities offering courses? Are commercial companies interested in the educational and training activities and project work? If you know of someone asking these questions, remind them that excellent careers literature provides the answers - and much more besides.

General careers literature is available from the Institution Secretariat. It includes wall charts and career briefs, all presented in an attractive, easy to follow layout, contact: **The Secretary, Institution of Agricultural Engineers, West End Road, Silsoe, Bedford. Tel: 01525 861096**

A Careers Brochure called *Rough Terrain Engineering* has also been published by Harper Adams and contains both general information on job opportunities, as well as more specific details on their degree course structure, contact: **Harper Adams University College, Newport, Shropshire TF10 8NB. Tel: 01952 815289**

## Membership movements

| *Mem No* | *Name* | *From* | *To* |
|---|---|---|---|
| 6213 | A M Allan | Oxfordshire | Warwickshire |
| 6524 | P W Amos | Tyne & Wear | Cumbria |
| 5740 | U B Bindir | Papua New Guinea | Nigeria |
| 6674 | S D Clark | Hertfordshire | Glasgow |
| 3382 | H D Cooper | Kent | Belgium |
| 6580 | D G Crabb | Warwickshire | Liecester |
| 6729 | R J Craven | Derbyshire | Essex |
| 6359 | N A L Gunn | Bedfordshire | Kent |
| 6744 | 0 R W Hiers | Bedfordshire | Belgium |
| 6746 | L K Kaptoge | Bedfordshire | Kenya |
| 6687 | M R Kitson | Cleveland | Staffordshire |
| 6558 | A M Lawson | Essex | Staffordshire |
| 5217 | B J Legg | Bedfordshire | Cambridge |
| 2406 | F McLean | Warwickshire | Gloucestershire |
| 2959 | C R B Orr | Oxfordshire | Uganda |
| 6745 | A J Puddephatt | Bedfordshire | Northamptonshire |
| 6169 | G R Rowlinson | Cheshire | Hong Kong |
| 6528 | K R Scrivens | Gloucestershire | Norway |
| 6566 | C V T Scullane | Warwickshire | Ireland |
| 6757 | M J Y Snell | Bedfordshire | Yorkshire |
| 6691 | M J Thakoordin | Guyana | Bedfordshire |
| 3657 | D B Williams | Ukraine | Warwickshire |

### Gone Away

| *Name* | *Last known Address* |
|---|---|
| Anthony Noel Curry | The Annexe, Saith Holme, 3 Upper Garston Lane, Bratton, Westbury, Wiltshire, BA13 4SN |
| Niamh Mary Foley | Cranfield University, Silsoe Campus, Silsoe, Bedford, MK45 4DT |
| Paul Michael Adrian Radford | 6 Wheatsheaves, Sawtry, Huntingdon, Cambridgeshire, PE17 5NG |

# Institution membership changes

## Admissions- a warm welcome to the following new members

**Companion**
R Smalley (North Wales)

**Member**
M A Andrews (Leicestershire)
D F H Giles (Bristol)
N J Paul (Wiltshire)

**Associate Member**
R T H Caplat (Staffordshire)
T E Carnell (Gloucestershire)
G M Dearsley (Cheshire)
R B Edwards (Lincolnshire)
N Elsender (Lincolnshire)
A P Mellor (Germany)
M Mutema (Gloucestershire)
G E Painter (Shropshire)
R A Smith (Warwickshire)

**Associate**
L O Adenuga (Kent)
D R Edmunds (Somerset)
M J Thompson (South Yorkshire)

**Student**
A M Buchanan (Buckinghamshire)
C G Cuinnea (Bedfordshire)
N M Foley (Bedfordshire)
R Paterson (Lanarkshire)
D L Pendergrast (Bedfordshire)
M J Powell (Bedfordshire)
G A Ross (Aberdeenshire)
G W J Seddon (Bedfordshire)

## Readmission
A B Gamble (Warwickshire)
A McCracken (USA)

## Reinstatement
P G Ridley (Northumberland)

## Transfers
– congratulations on achieving a further phase of your professional development

**Member**
C J W Rylands (Spain)

**Associate Member**
E Davidson (Norfolk)
J S Garner (Buckinghamshire)
M C W Home (Shropshire)
L K Kaptoge (Kenya)
M R Kitson (Cleveland)
S M Maguire (Northern Ireland)
A D B Shorten (Cornwall)
S W Wise (Bedfordshire)

**Associate**
M S Atyeo (Dorset)
J R Bishop (Worcestershire)
M Dunn (Lancashire)
N M Foley (Bedfordshire)
L K Jordan (Essex)
O A Kemp (Kent)
T J Lane (Hampshire)
A M Lawson (Essex)
I M MacKinnon (Inverness)
P D Mitchell-Roberts (Norfolk)
P J Moseley (Bedfordshire)
I R Petts (Surrey)
L D Pritchard (Worcestershire)
A J Puddephatt (Bedfordshire)
G S Rogers (Lancashire)
M J Y Snell (Bedfordshire)
S G S Steger-Lewis (Hampshire)
S N Townshend (Clwyd)
V Tsakiris (Essex)
C H A Young (Surrey)

## Death – with great sadness, we record the death of:
K W Pape (Nottinghamshire)

# Engineering Council

## Registrations

**CEng**
T B Adhikarinayake (Sri Lanka)
M McKee (Staffordshire)

**IEng**
M A Andrews (Leicestershire)
M T Payne (Somerset)

# Pioneering Group news: web site

Another first for the group noted for publicising pioneering developments. Web browsers may have already found it, certainly those who regularly visit the Institutions web site at **www.iagre.demon.co.uk** will have noticed that under branch and specialist groups there is one specialist group that has its own page. This page gives a little about the aims of the group and lists the meetings it is publicising.

We have selected as a heading photo a picture of a TE20 tractor. This was the tractor that revolutionised farming. It was light-weight using hydraulic control, rather than just using heavy tractors, to apply weight for traction. It was one of the great breakthroughs from which all modern tractors have developed.

Please visit our (and your) web site. If your branch is running any technical meetings that you would like us to publish as a combined meeting please contact: **William Waddilove - tel: 01203 544255. E-mail: william@waddilove.u-net.com**

# News *of Members*

Our President, **Brian Legg**, has left Silsoe Research Institute to become Director and Chief Executive of the National Institute of Agricultural Botany, Cambridge.

**Justin Rylands** has resigned from G's Espana and has taken up employment with a manufacturer of specialised agricultural machinery based in Murcia, Spain.

**David Crabb** who works for Caterpillar (UK) Limited has been seconded to work in North Carolina, USA for a period of two years from the beginning of October 1999.

**Dr Umar Buba Bindir** has become Deputy Director (Operations) for the Family Economic Advancement Programme (FEAP) based in Nigeria. FEAP is the main poverty alleviation programme set up by the Nigerian Government to assist poor people through encouraging them to invest and be economically busy. The programme operates directly under the Presidency. One of their main interests is to deliver cheap micro-credit (small loans of money) to people and promote investment in agricultural production and processing activities. Part of his job is to assist in the proper choice of cottage projects, (such as peanut oil production, cassava processing and mineral kaolin processing, all of whose basic raw materials are available locally) and help prepare feasibility reports on the scale of investment and production control. The next step is to assess the required inputs (including machinery needs) and to arrive at an amount to be loaned for the project. Based on all these findings they then assist in the field project take-off by providing training and supervision. Umar participates in the formulation, production and implementation of all training modules for various needs such as for the unit project processes, use of machinery and equipment, running and upkeep of equipment and financial management. He is also involved in the formulation and execution of project monitoring and evaluation, to trouble-shoot project problems and give the programme a chance to continue "long term". He is also responsible for organising, running and maintaining the programme Management Information System.

Umar says that he is finding the job challenging, satisfying and rewarding and has the privilege to work with the people and for the people, and so far both parties are happy and satisfied.

Congratulations to **Neil Gunn** on the award of a Masters degree in Soil and Water Engineering at Silsoe. Neil is now a Development Control Officer with the Environment Agency at Addington in Kent. He says that his department is involved in the planning process where land drainage consents are required or where development has an effect on flood defences or land within the floodplain.

**G R Rowlinson** is now living in Hong Kong and is employed as the Workshop Superintendent for Paul Y Tunnel Engineering Co Ltd.

**R C (Dick) Bilborough** who has recently received his 35-year Membership Certificate is Managing Director of Teg Environmental plc. He says that in 1996, after two and a half years diligence, both here and in the USA, he has backed the technology and invention of a Lancastrian scientist, Dr Alan Heyworth, formerly on the faculty of the University of Wales, Aberystwyth. Dr Heyworth has had a family background in the fertiliser business followed by his academic career which had focused on the composting of all types of organic waste to create organic fertilisers of varying value.

Dick's role has been to provide management and funding, and to develop the garden scale prototype into an industrial scale plant capable of continuous operation with mechanical loading and unloading. Nearly four years later and with £3m of investment by private individuals, they have moved from large prototype to pilot plant and now to production design. Over the past two years they have processed many types of organic wastes successfully from the water, pharmaceutical, food, brewery/distillery and explosives industries, as well as abattoir and fish wastes. These trials culminated in July with successful industrial scale trials of both digested and primary sewage sludge for major water companies.

Dick says that they had, from the outset, focused on the industries which were to be among the first to be affected by incoming EU and UK legislation, hence their initial target was the Water Industry. The plant which they have developed is known as the TEG Silo-Cage system, which is an agricultural engineered product aimed at other industries but with the expectation that agriculture will provide a second market as legislation comes to bear on farming waste over the next five years.

*Tony Chestney*

## Long service certificates

### 50 years

| *Name* | *Grade* | *Date of Anniversary* |
|---|---|---|
| George Alfred Stanley **Frank** | IEng MIAgrE | 1 Oct 1999 |
| Reginald Fred **Norman** | CEng FIAgrE | 14 Oct 1999 |
| John Eugene **Colman** | FIAgrE | 1 Dec 1999 |
| Charles Lewis **Fox** | MIAgrE | 1 Dec 1999 |

### 35 years

| | | |
|---|---|---|
| George Lironi Taylor **Hunt** | IEng MIAgrE | 12 Nov 1999 |
| Don Karunasena **Samarasinghe** | IEng MIAgrE | 12 Nov 1999 |

### 25 years

| | | |
|---|---|---|
| Geoffrey Reginald Albert **Miller** | MIAgrE | 21 Oct 1999 |
| Richard Christopher Gower **Danby** | MIAgrE | 21 Oct 1999 |
| William Albert **Johnson** | EngTech AMIAgrE | 21 Oct 1999 |
| Reginald Vincent **Ward** | IEng MIAgrE | 21 Oct 1999 |
| Peter Dennis Richard **Grinham** | MIAgrE | 23 Oct 1999 |
| Robert Leslie **Pilcher** | EngTech AMIAgrE | 7 Nov 1999 |
| William Wilson **McKinlay** | IEng MIAgrE | 29 Nov 1999 |
| Christopher George **Nendick** | AIAgrE | 1 Dec 1999 |
| Martin Edward **Rees** | IEng MIAgrE | 16 Dec 1999 |
| John **Dumelow** | CEng MIAgrE | 16 Dec 1999 |
| Colin Gregory **Fountain** | AMIAgrE | 16 Dec 1999 |
| Arthanari **Mani** | IEng MIAgrE | 16 Dec 1999 |
| David Corfield **Black** | IEng MIAgrE | 16 Dec 1999 |

# Engineering Council Activity Review

Until now I have studiously managed to avoid the millennium fever that is sweeping the country - especially the most virulent 'new millennium, new beginning' strain of the disease! Somehow though, I now find myself succumbing and beginning to warm to such sentiments. Not so much because of the millennium itself, but because, at last, the Engineering Council has completed the comprehensive Activity Review that has dominated its attentions during 1999 and genuinely appears to be on the threshold of a new age.

I am well aware that similar optimistic claims have been made before, both by and for the Council. This time, though, I think there are sound reasons for believing it is the real thing and not just another false dawn. After a lengthy period of introspection, we are finally in a position to start looking outwards and getting on with the job we were set up to do - promoting and regulating the engineering profession effectively.

At the end of September, the Engineering Council Senate was presented with plans for a radical change in direction when it received the *Activity Review Implementation Report*. The Report is the result of a year-long profession-wide evaluation of the Council's core activities, aimed at assessing how the Council can better represent the interests of its various stakeholders - principally individual engineers, Institutions and engineering industry. Allied to the existing strategy document Engineering 2005, it maps out the way forward for the Council and the profession into the next century.

The main thrust of the Report is that the Council should seek to pass on mature, well established tasks to other organisations that are equally well or better equipped to run them successfully. This will create resource 'headroom' that the Council can then use to take on new tasks – ideally with a time-life and cost neutral – that, it believes, will help move the profession forward more quickly and more effectively. It will also allow us to tailor our activities better, in order to benefit more directly the 280,000 professional engineers and technicians on our national register.

So how will the recommendations of the Report translate into action? Well, we are already working on one of them - a major new campaign, to be launched next year, aimed at promoting the benefits to companies of employing registered engineers and Institution members. This should benefit professional engineers directly by raising awareness of their value to employers and, ultimately, providing them with enhanced career opportunities, prospects and status. The 'end game' aim is to persuade employers to insist on Institution membership and registered status when recruiting engineer employees. We recognise fully the size of this task but believe that it is achievable.

We are also acting on the Report's recommendation that we should continue to work ever more closely with the Institutions to secure maximum benefits for our respective customers - members and registrants. Our collaborative work on implementing the third edition of *Standards and Routes to Registration* (SARTOR), is a good example of this. Developed and agreed by the profession for the profession, SARTOR is the engine for maintaining and raising standards and of ensuring that the profession produces engineers who match precisely the needs of industry. Employers are demanding professional engineers and technicians with a broad range of different skills - some with advanced theoretical and analytical skills and others with more practical, applications-oriented skills. The implementation of the new SARTOR will, over time, ensure that the profession meets this demand.

Adopting the recommendations of the Activity Review Report and re-focusing our activities in the way it proposes, reflects the Council's commitment to being more flexible and proactive in responding to its customer needs - and I am pleased to say that registrants are already reaping the benefits. Greater efficiency and some staff rationalisation have already given us net cost savings of mote than £100,000 per year, allowing us to freeze registration fees for the year 2000. There will undoubtedly be further savings to come as we implement fully the recommendations of the Activity Review.

I believe we have reached an important milestone. We now have a vision for the engineering profession that has been created by the whole profession and seeks to foster the best interests of all within it. After more than a year of consultation, the Activity Review Report is now being implemented and Engineering 2005 will be ready for launch as planned on 1 January 2000. The shared vision of the way forward, created and owned by the Engineering Council and its partner engineering Institutions, provides a platform to inspire and direct the longer-term future of the profession.

We are understandably very excited by our plans for the future and want to involve all registrants in them. So we are using the latest technology to communicate on a direct but cost-effective basis with registrants through a new, interactive web site at www.engineering2005.25.

The site, which has been running since 7 October, presents an imaginative and entertaining visual interpretation of the Strategy, *Engineering 2005*, and will bring registrants bang up to date with what is being proposed. Because it is interactive, it allowed registrants to comment on the Strategy and gave each and every one of them the opportunity to make their voice heard. The site remained open for comments on the Strategy until December. All comments received were reviewed and, where appropriate, fed into the final draft of the Strategy before it was presented to the Senate for endorsement at the December meeting.

Behind all the hype, there is no doubt that the year 2000 really does represent a landmark for the world. It is a time to look back, certainly; but, more importantly, it is a time to look forward. I am confident that all the hard work done by the Engineering Council and its partner Institutions during the final year of this millennium - and the firm foundations laid - puts us in excellent shape to look forward with confidence to the next.

*Malcolm Shirley, Director General*

Produced by: Land Technology Ltd, Edinburgh

Printed by: Barr Printers, Glenrothes

INSTITUTION of AGRICULTURAL ENGINEERS, WEST END ROAD, SILSOE, BEDFORD, MK45 4DU, UNITED KINGDOM. Tel: 01525 861096 Fax: 01525 861660

# Structural engineering opportunities for timber

**Rob Bainbridge and Martin Milner**


## Synopsis

*This paper describes recent developments and trends in timber engineering which have broadened the scope for innovative and efficient structural design. A brief overview of the development of timber buildings through the twentieth century is provided and recent trends in material specifications and design codes are discussed. Innovative connection systems are also described and case studies of modern timber structures given.*


***This paper was presented at the 1st International Conference on Forestry Engineering entitled: "Forestry Engineering for Tomorrow", organised by the Forestry Engineering Group of the IAgrE and held at the University of Edinburgh, Scotland, UK on 28-30 June 1999.***

***Rob Bainbridge is Research Engineer and Martin Milner is Engineering Group Manager, both with the Timber Research and Development Association at TRADA Technology Ltd, High Wycombe, UK.***

## Introduction

Timber is not yet used to its best effect in design in this country. This, in part, may be due to a lack of education on its very real benefits among students and also to historic limitations which no longer apply.

*Figure 1* shows a timber frame system demonstrating all the key points of today's construction ideas: pre-fabricated, modular framing, interchangeable parts, re-usable elements, low energy (both in material and erection), aesthetically pleasing and exploitation of native material. From this description it would appear that this is an ideal building for the twenty first century, although cruck frames of the form illustrated were universally built in Britain over 500 years ago. Unfortunately, this also illustrates the widespread perception of the technological limits of structural timber and perhaps maintains a romantic image of timber structures.

Using similar principles of modular construction and efficiency of design to those illustrated by the cruck frame, engineers in mainland Europe have demonstrated the potential of timber in large span modern structures. *Figure 2* illustrates an example of what can be achieved through understanding material and structural forms which optimise the bending and compressive strengths of timber. The geodesic dome has a diameter of 115 m and is constructed using Kerto LVL structural timber composite material.

The importance of timber has been formally recognised in a document entitled 'Timber 2005 - A Research and Innovation Strategy for Timber in Construction', produced by the DoE (1996) working closely with the timber industry, which outlines ways to exploit the advantages of wood, particularly UK grown products, in a move towards sustainable development. Amongst the initiatives is a call to demonstrate the efficient use of timber and the development of new products and design principles that will meet the needs of the modern construction industry.

The biggest obstacle to timber engineering is the education of engineers and other construction professionals in the use of timber. To most UK structural engineers, timber is a low technology product to be learnt through 'on-the-job' training and experience. A review of undergraduate and professional training courses in construction and building in the UK shows that timber technology, if taught at all, is given very low priority in the syllabus compared with other building materials. Efforts have recently been made to address this situation, most notably through the pan-European STEP (Structural Timber Engineering Programme) initiative (Blass *et al.*, 1995a and 1995b).

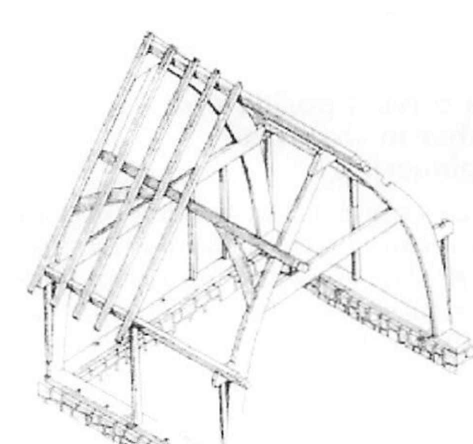


**Fig. 1 Cruck frames - the romantic image of timber or an advanced three pin arch modular form of construction?**

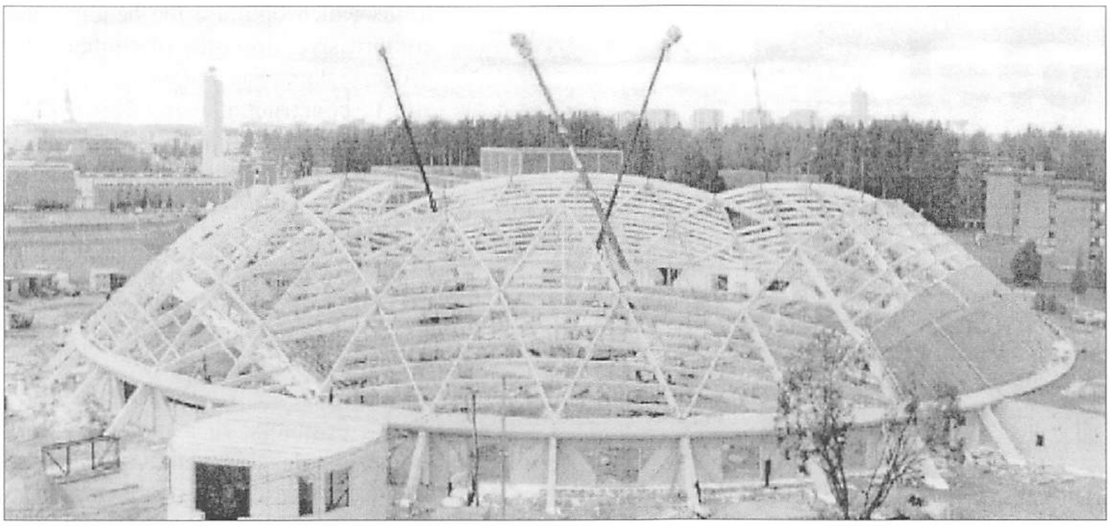


Fig. 2 Oulu-Dome during construction, Oulu, Finland

choice of material in the design and build process.

## Exploring the benefits of timber

The first question to answer in presenting engineers with timber as a potential material choice is 'why bother?' The following are some of the key benefits of timber.

**Table 1 Principal uses of structural materials related to building type**

| *Building type* | *Principal structural materials* | | |
|---|---|---|---|
| | *1900s standard* | *1990s 'auto-pilot' selection* | *The under-utilized 1990s timber option* |
| Domestic houses | Loose cut timber roof structures on masonry walls and timber floors | Trussed rafters on brick/concrete block walling with concrete ground floors | Module platform frame fast track construction or masonry walling with long span I joist floor and roof framing. |
| School buildings | Loose cut timber roof structures on masonry walls and timber floors | Framed structures using steel and concrete | Factory made timber frames and composite floor beams in fast track *'platform frame'* construction* |
| Warehouse units | Steel angle trusses on masonry walls | Steel portal frame buildings | Structural composite timber portal or 3 pin arch. |
| Medium rise buildings | Loose cut timber roof structures on masonry walls and timber floors | Framed structures using steel and concrete or masonry and concrete floors | Multi storey, prefabricated panel, timber frame construction, designed against disproportionate collapse |

*Wainright and Keyworth (1988)

## The current position of timber in structural engineering

The decline in the use and knowledge of timber as a primary construction material is highlighted by the choice of material for framing. Table 1 reviews of the building materials most commonly selected, perhaps by auto-pilot, by design professionals for a range of building types.

Table 1 demonstrates how timber has lost market share in a number of applications to steel and concrete. To most UK designers, timber engineering is centred on domestic products such as trussed rafter framing and floor joists and simple glulam structures where the aesthetics of timber are a central theme in the architects' design.

If timber is selected, it is likely that the structural engineer will allow the design to be carried out by others (Table 2).

It is no wonder that engineers are unfamiliar with timber and cautious about using it if their experience is restricted to the above. To change this is clearly a monumental challenge. Only by demonstration and development of products that address market needs, will timber be considered an appropriate

**Table 2 Design route for common examples of timber structural elements**

| *Item* | *Common design route* |
|---|---|
| Trussed rafters | Design by others,<br>loads only 'checked' by structural engineers |
| Floor joists | Usually derived from span tables for designated load |
| Glulam beams | Structural engineer or specialist contractor |
| Bridge framing | Structural engineer or specialist contractor |

*Energy Issues*

As the only truly renewable building material, timber has high ecological attributes. It acts as a carbon sink and has low embodied energy: if it were invented today, it would surely be hailed as an environmental wonder product.

The energy needed to convert trees into wood and hence into structural timber is significantly lower than that required by other materials, such as steel

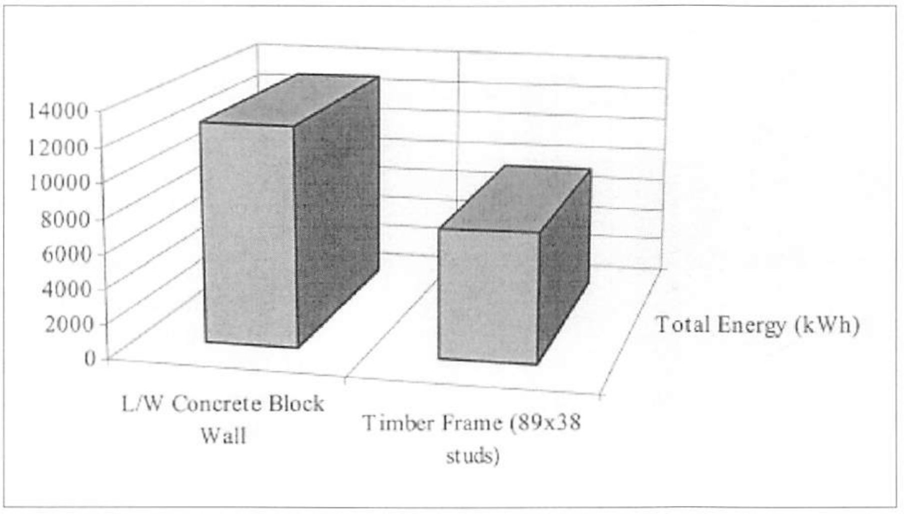



**Fig. 3 Comparison of production energy requirements for timber frame and lightweight concrete blocks**

and concrete. *Figure 3* compares the production energy requirements for light weight concrete block and timber frame walls.

This point is further demonstrated by comparing the energy requirements for beams in steel, reinforced concrete and timber, as illustrated in *Fig. 4*.

*Structural efficiency - strength to weight*
Timber has a high strength to weight ratio. This is illustrated through a comparison with steel in *Fig. 5*.

*Utilisation potential for home grown resources*
It is both economically and politically important that the UK utilises its native resources. Historically, structures in the UK relied heavily on native temperate hardwoods such as oak and elm, but today's timber structures are more usually imported softwood and hardwood species. However, there is an important natural resource in the coniferous and broad-leaved species now growing in the UK.

Although this resource is limited in terms of variety and abundance compared with the range of imported timber, it still has potential either as primary structural material or as an aesthetic medium for high quality construction. The range of applications for the UK resource is broadened by its utilisation in a timber composite. For example, species such as British-grown Sitka spruce have been used to produce experimental structural timber composites on a commercial scale (Mettem, 1995).

*Familiarity on site*
Timber is relatively lightweight, easy to cut and fix and adaptable to site alteration.

## Developments in wood based structural materials

Modern timber technologies have produced innovative ways of using wood which deliver a construction material with the flexibility and quality necessary for competitiveness.

Table 3 provides a classification of wood products set out in a family tree from solid wood through to composites manufactured from wood fibres.

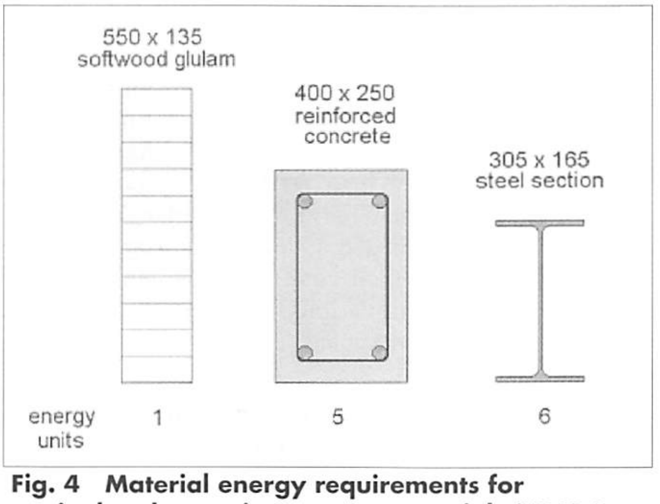



**Fig. 4 Material energy requirements for equivalent beams in common materials (TRADA, 1995)**

Composite materials are not entirely new in timber structures. Timber itself has a composite micro structure and timber as a component of composites, such as glulam, is widespread and historically proven, with UK examples of glued-laminated timber structural members dating back to the 1860s (Booth, 1994). In recent years, however, there have been significant developments in the types and availability of timber composite materials for structural applications, with materials such as laminated veneer lumber (LVL), parallel strand lumber (PSL), laminated strand lumber (LSL) and pre-fabricated timber I beams becoming more widely available.

Advantages of structural timber composites (STCs) include improved structural properties and dimensional stability, large sections and lengths, reduced overall wastage of the timber resource, less material variability, aesthetic variety and utilisation of logs unsuitable for conversion to sawn timber (Mettem *et al.*, 1996).

Structural timber composites present new opportunities for timber structural members. The products are manufactured from veneers, strands and fibres cut from young or waste timber and reconstituted. There is a major benefit to strength and stiffness properties by recomposing wood, which also greatly reduces the variability inherent in natural timber. This leads to an overall increase in the average material properties and comparatively higher minimum design values, derived from a five percentile value. This is illustrated in *Fig.7*, which shows the mean and minimum values of modulus of elasticity associated with a range of softwoods, hardwoods and structural timber composites.

Since structural timber composites are factory produced, the only constraints on length and section size are the practicalities of transportation and handling. In addition, the products are produced at low moisture contents therefore reducing the risk of movement due to drying in service in internal environments.

The manufacture of STCs using UK timber is clearly an attractive proposition, particularly if the abundance of low grade timber can be exploited. In America, for example, structural timber composites have been produced from low grade hardwoods, (aspen and maple) and a

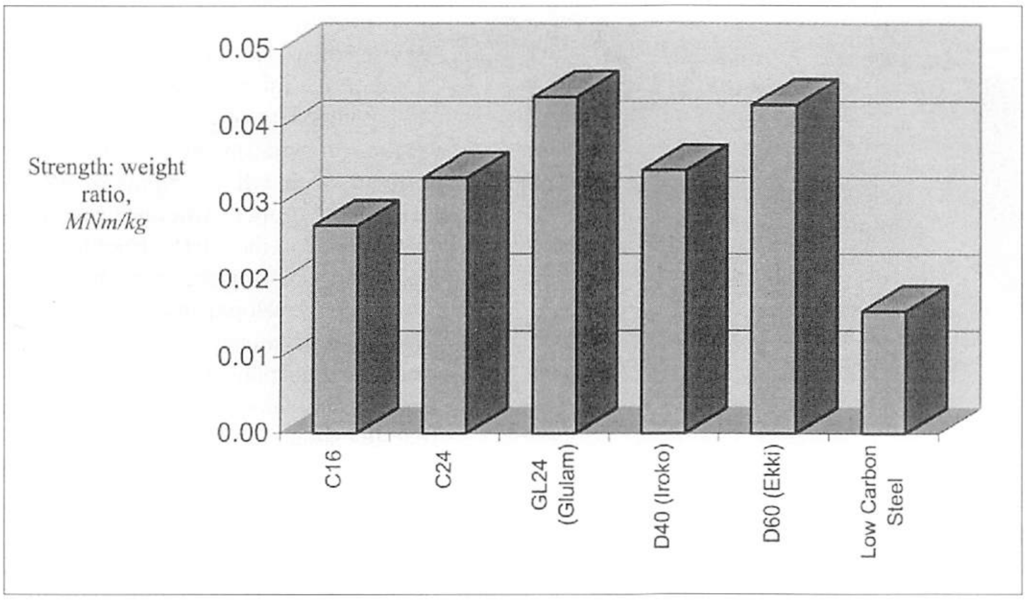



**Fig. 5 Strength to weight ratios for a range of structural materials**

competitive higher grade structural material called laminated strand lumber (LSL) is available.

Research is in progress on a global scale on the development of STCs the most promising involving the incorporation of fibrous materials such as glass, carbon and aramid. These may be a means improving strength, stiffness or both whilst not significantly increasing the density, and hence the weight, of structural elements. Table 4 illustrates the relative properties of the common fibre materials.

Although STC materials have certain clear advantages, measures can be taken to obtain the best results from timber in its traditional sawn state. The most obvious is through specification of moisture content, since all material properties (with the exception of toughness) tend to increase as moisture content is reduced, as illustrated in *Fig. 8*.

## Design code support

There is a range of design codes applicable to the design and specification of timber in structural applications. These can be placed into three main categories:

*a) simplified design codes* - for use by individuals with a limited technical appreciation or in instances where full calculation of individual structural elements from engineering principles is not practical, these codes using devices such as span tables and typical construction details to convey solutions within a limited scope, *e.g.* BS 8103;

*b) structural design codes*- for use by structural engineers in conjunction with design guides, *etc.* and engineering judgement, *e.g.* BS 5268, Eurocode 5, Eurocode 1; and

*c) supporting codes and documents*- relating to specific items such as material specifications, definition of design loads, *etc.* and statutory design requirements, *e.g.* British Standards, Euro Norms (ENs/prENs), International Standards (ISOs), and Building Regulations and Approved Documents.

In design, the limit state code for timber, Eurocode 5, has produced a workable and more economical design method. It provides opportunities for UK designers to use timber for new applications that will give economic solutions as it allows scope for new materials, such as the structural timber composites, and new efficient jointing techniques. The way that the code is structured will encourage engineers to obtain a greater understanding of the behaviour of timber which in turn will provide a platform for excellence in timber engineering structures. Some of the knowledge gained in Eurocode 5, has been translated into a new, fully revised, working stress code, BS 5268: 1996. A prime example of how design code changes can facilitate innovation is in structural timber connections.

**Table 3 Wood product classification**

| *Type* | *Wood element* | *Wood composite name* | *Example of use* |
|---|---|---|---|
| 1. Natural | Natural composite | Solid timber | Structural framing - small, general carcassing, door panels, general joinery. |
| 2. Laminated composite | Sawn timber sections | Glulam, mechlam | Structural elements - large to small framing, window joinery. |
| 3. Structural timber composites | Veneers | Laminated veneer lumber (LVL), parallel strand lumber (PSL), plywood | Structural elements - large to small framing, general carcassing, door panels, general joinery, furniture and boarding |
| | Flakes | Laminated strand lumber (LSL), oriented strand board (OSB), waferboard, flakeboard | |
| 4. Particleboard | Particles | Chipboard, flaxboard, cement bonded particleboard | Flooring, ceiling and panel infill. |
| 5. Fibre boards | Wood fibres | Hardboard, softboard, medium density fibreboard (MDF) | Moulding, internal joinery and panel infill. |

## Improved and innovative connections

The use of timber for medium and larger span timber buildings (for which there is

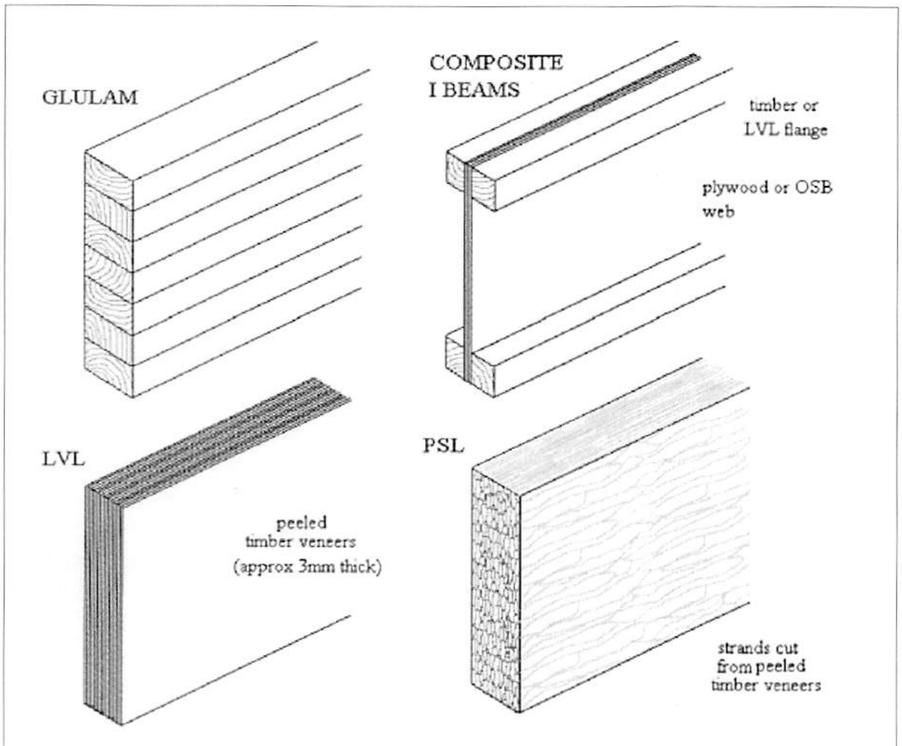



***Fig.6 Examples of structural timber composite materials***

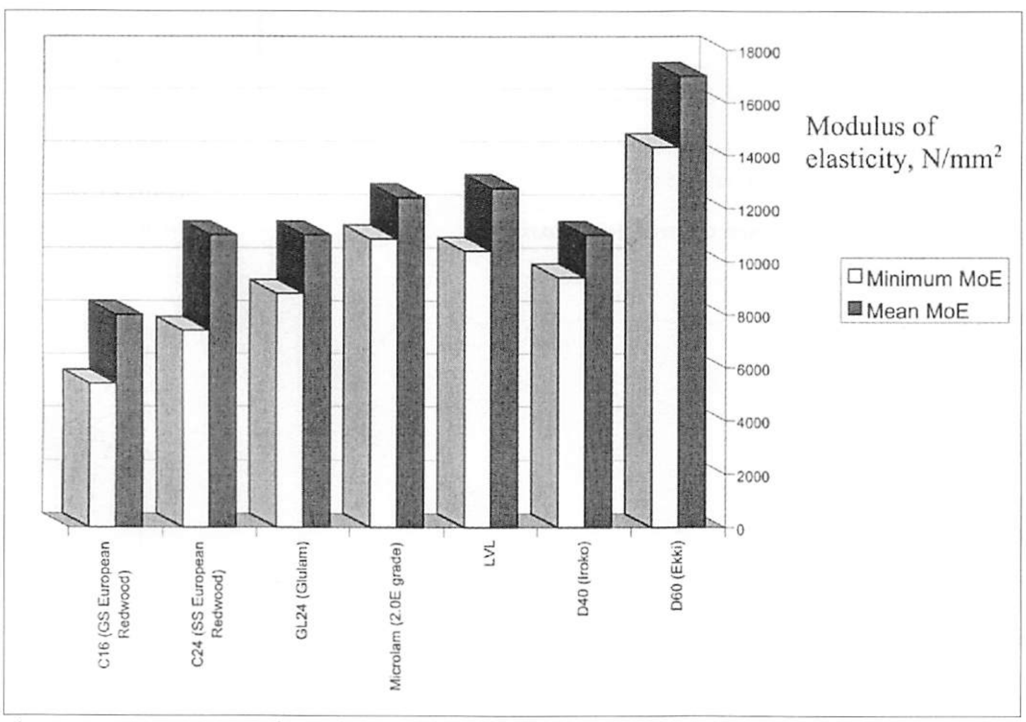



**Fig 7. Comparison of modulus of elasticity (MOE) and associated variation with various timber grades and structural timber composites (STCs)**

a great social need), has been severely restricted by the cost of forming the principal connections between the main structural members.

Eurocode 5 allows a greater range of options than previous UK design codes, on methods of jointing, both through provision of wider ranging general guidance and a less prescriptive overall ethos.

A recent survey of innovative structural timber connection systems (Bainbridge & Mettem, 1997 and 1998), both those commercially available and in the realms of research, has highlighted the wide range of possibilities. Prominent innovative systems include concealed bonded-in rods and plates, adhesive bonded surface contact joints, timber connectors within lapped joints and dowel type connections.

Recent research at TRADA Technology has been focused upon connection systems where the majority of the connection components are concealed. *Figure 9* shows a hypothetical structure in which a number of different connections can, to a greater or lesser extent, be concealed from view in the completed framing. There are a number of good reasons, primarily visual, why concealed systems are beneficial. This is of considerable importance to architects and clients. Fire performance may also be improved by the concealment process. Other aspects which must be maintained or improved at the same time include good detailing, ease and accuracy of site assembly, safety, reliability and service performance.

Work is currently in progress exploring the possibilities of employing materials such as fibre reinforced polymers (FRP) in order to produce structural timber joints. Potential advantages include workability of components with hand tools, lower component weight in large connections, closer compatibility of materials, promoting a higher absorption of energy prior to failure of joints (Drake *et al.*, 1996).

## Case studies of efficient timber construction in the 1990s

The following examples highlight the advantages of timber as a structural material. *Figure 10* illustrates some examples of timber structures in the sectors identified previously in Table 1.

The school buildings illustrated in *Fig. 10a* were built by Devon Design Practice, a self contained business unit within Devon County Council. A number of different building methods were evaluated and timber frame construction was found to give the best results in terms of capital cost and energy efficiency. In addition, the speed of erection meant that the schools could be completed within a shorter contract period. A further factor was the ecological value of sustainability in specifying timber.

The timber frame houses illustrated

**Table 4 Comparison of typical material properties (CEN, 1993; BSI, 1985; Quinn, 1995)**

| *Material* | *Density, kg/m³* | *Tensile modulus, kN/mm²* | *Tensile strength, N/mm²* |
|---|---|---|---|
| Timber (C24) | 420 | 11 | 14 |
| Timber (D60) | 840 | 17 | 36 |
| Low carbon steel (43) | 7870 | 205 | 275* |
| High tensile steel (50) | 7870 | 205 | 355* |
| E glass fibre | 2570 | 72.5 | 3330 |
| S-2 glass fibre | 2470 | 88 | 4600 |
| Aramid (Kevlar 29) | 1440 | 58 | 3620 |
| Aramid (Kevlar 49) | 1440 | 124 | 3620 |
| Carbon fibre (T300) | 1760 | 230 | 3530 |
| Carbon fibre (T1000G) | 1800 | 294 | 6370 |

* Yield strength

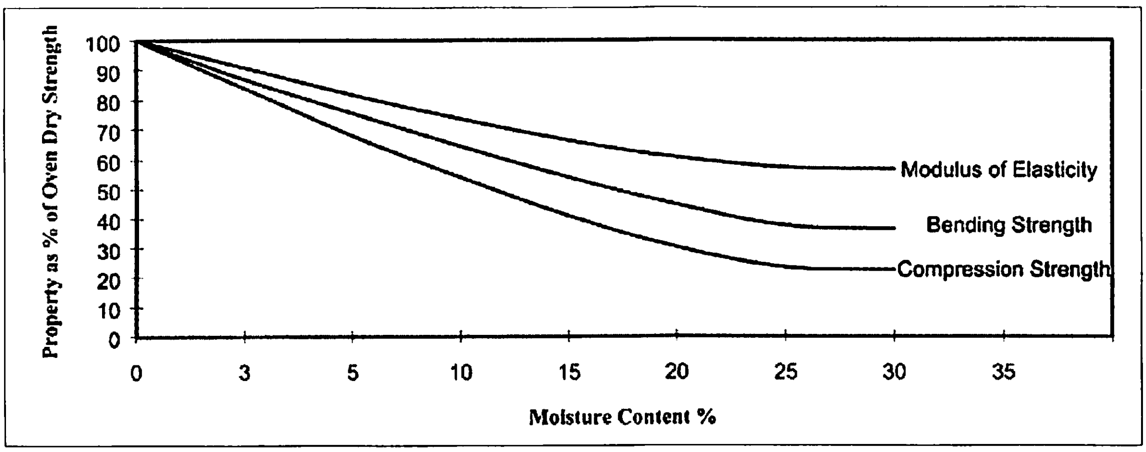



***Fig. 8 Variation of timber properties over a range of moisture content***

in *Fig. 10b* employed long span wood I-beams for the floors and roof to eliminate the need for internal load bearing walls. The internal space is, therefore, entirely flexible and with the use of demountable partitions can be arranged to suit the occupants' requirements and altered at any time to suit changing accommodation needs. The I-beams used for the wall construction provide space for high levels of thermal insulation in both the wall and roof panels without increasing the building's footprint. In addition, the low dead weight makes it ideal for situations where ground conditions are poor.

The medium-rise timber frame building shown in *Fig. 10c* is the subject of a current research project, 'Timber Frame 2000', which is to include full scale testing relating to various aspects of structural performance (Mettem *et al.*, 1996).

The warehouse structure in *Fig. 10d* was built by Cowley Structural Timberwork Ltd. Kerto LVL portals were used to attain a simple, economic and competitive solution.

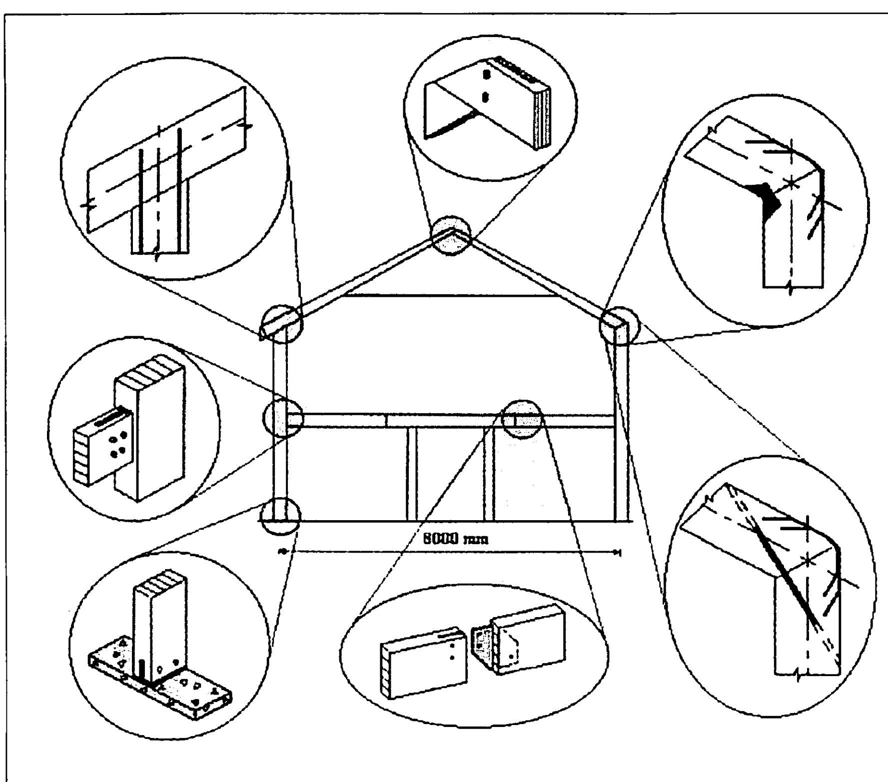



**Fig. 9 A conceptual building illustrating different concealed connections**

*Figure 11* illustrates some further examples of timber structures in applications beyond the traditionally recognised domain of domestic and small scale industrial buildings.

*Figure 11a* illustrates the 50 m span glulam dome that forms the exhibition hall of the Bournemouth International Centre. The size, structural form and aesthetic impact of the timber combine to form an impressive and interesting structure.

The covered walkway in *Fig. 11b* illustrates the potential to create interesting, functional structures employing the timber resource highly efficiently. In this case Welsh oak has been used in a glued laminated form for the primary structural members, creating a high value added construction product.

*Figures 11c and 11d* are examples of recent timber structures located elsewhere in Europe. The roof structure of the new airport check-in hall at Oslo is one of the most impressive and innovative timber structures in the world. The structure consists of a series of serpentine glulam trussed girders 136 metres in length. It illustrates the progression of knowledge and

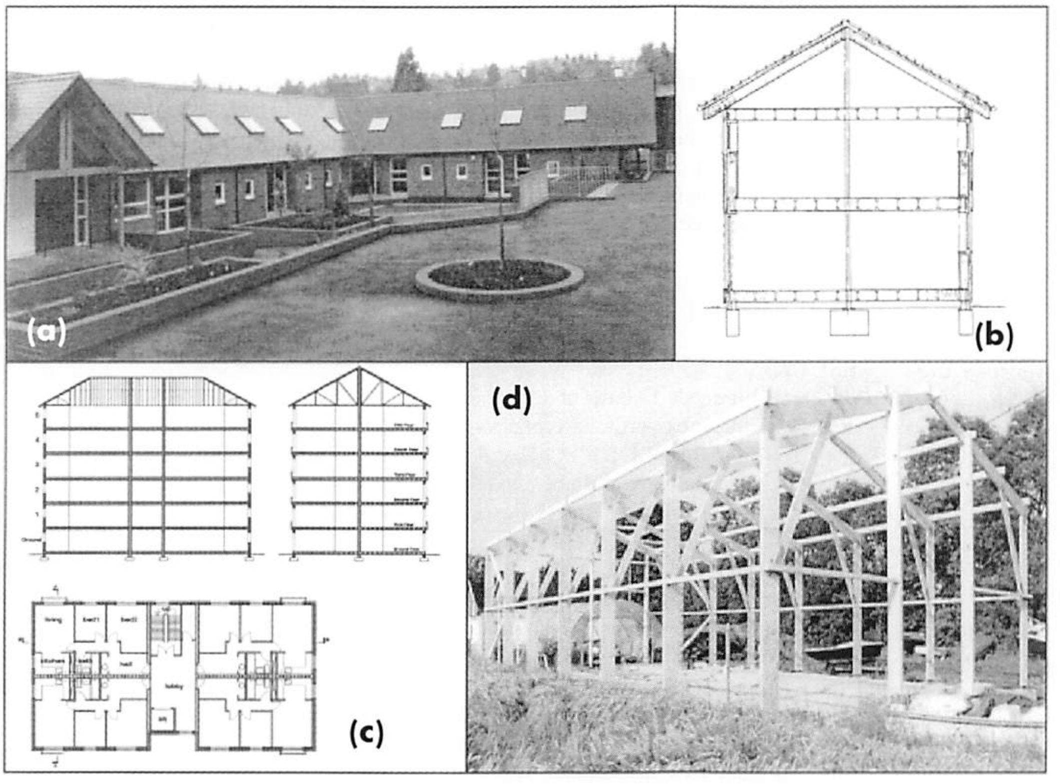



**Fig. 10 a) New School buildings for Devon County Council**
**b) Timber framed houses - TTL Futureworld House in Milton Keynes**
**c) Timber Frame 2000 Test Building**
**d) Warehouse - Morton Boatyard**

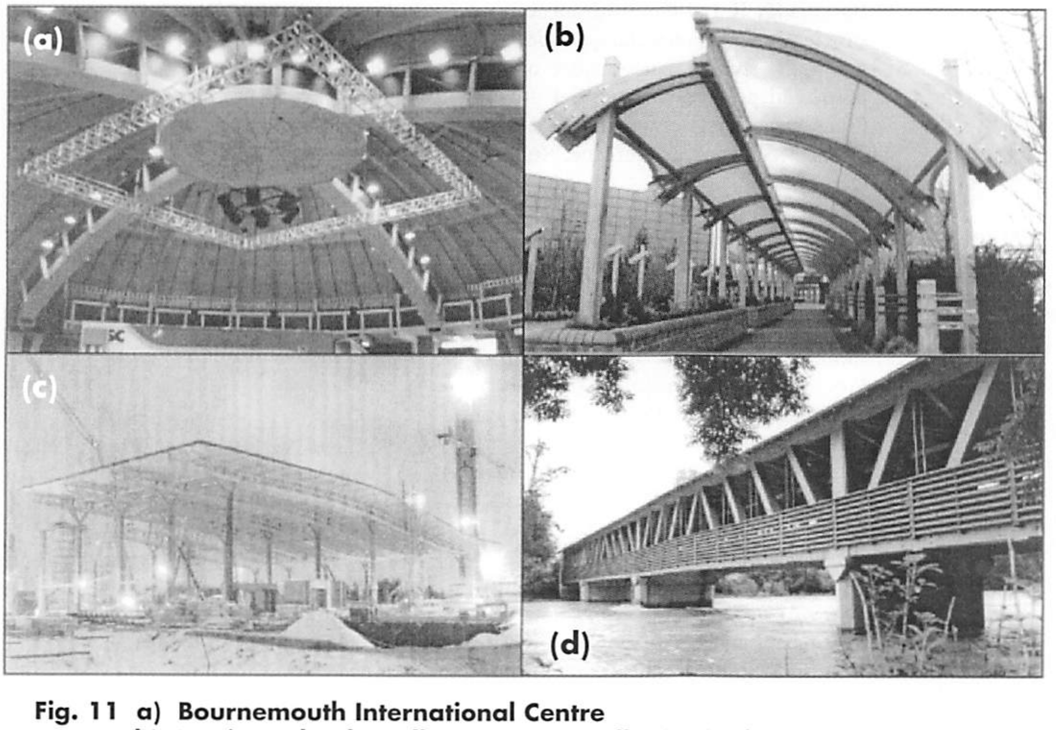



**Fig. 11 a) Bournemouth International Centre**
**b) Laminated oak walkway, Merry Hill, Birmingham**
**c) Check-in hall, Oslo Airport (during construction)**
**d) Glulam road bridge, River Thur, Andelfingen**

expertise developed during the construction of the main halls for the 1994 Winter Olympic Games in Lillehammer that brought world focus on such structures.

The glulam road bridge in *Fig. 11c* is representative of a large number of bridges found in mainland Europe. It demonstrates that the scope for timber in bridge structures need not be restricted to small span pedestrian bridges.

## Commercial considerations

Timber structures are, in general, more lightweight than alternative solutions employing other common structural materials. In addition to benefits of such as reduced foundation requirements and ease of lifting during transportation and assembly, there are also wider benefits to the overall construction project. A recent commercial assessment of medium rise timber frame structures (Enjily & Palmer, 1993) concluded that key drivers encouraging the use of timber frame are reduced construction time, systematised construction approach and increased energy efficiency.

Overseas studies involving advanced structural timber composite prototype materials in real applications have further demonstrated the commercial potential of timber. It has been reported (Tingley, 1993) that the use of fibre reinforced glulam in beam bridges can lead to substantial savings in cost compared to the non-reinforced glulam option, which itself is a commercially viable and commonly encountered solution in continental Europe and North America.

## Conclusions

There is much expertise in this country in the use of timber in building. However, because timber is used less as the primary structural element than other materials, the transfer of knowledge across the industry is restricted to those who wish to find out.

Developments in material availability, new technologies and the introduction of less prescriptive design codes present great opportunities for innovative design in timber and wood based materials.

## Acknowledgements

This paper was developed from research sponsored jointly by the Department of the Environment Transport and the Regions (DETR) and the Timber Research and Development Association. TRADA Technology gratefully acknowledges their sponsorship and thanks them for their support.

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# The European market for agricultural machinery

Rising interest and customer confidence is anticipated to sustain growth in the European agricultural machinery market, says a new study by Frost & Sullivan, the international marketing consulting company. Improved customer service, technological innovation and competitive prices are further factors anticipated to push revenues in this market from $13.83 billion in 1998 to $17.04 billion in 2005.

As global food requirements are increasing and becoming more sophisticated, Frost & Sullivan identifies the ongoing need for more efficient farming methods as a major driver behind the dynamism of the total market. Mik Sabiers, Industry Manager at Frost & Sullivan, adds: 'To meet the rising demand for a more varied source of foodstuffs, customers of agricultural machinery have looked to strengthen their overall productivity and efficiency by purchasing more advanced and enhanced equipment.'

Further factors stimulating sales in the agricultural machinery market include intensified R&D, the introduction of more powerful machinery and more stringent legislation regarding safety and environmental protection. The main rise in interest is expected for more advanced and effective technology, with users focusing on higher power tractors and other agricultural machinery that is able to improve farm and general agricultural productivity and performance.

Of the regional markets, the single largest country in terms of demand was France, representing 20.3 per cent of total market revenues in 1998. The French market is forecast to increase its dominance in the European agricultural machinery market, benefiting from a continued focus on the agricultural sector and the wide customer base investing in advanced and effective technology.

The combined tractors market is one of the most important areas of the market, with a wide range of different tractors utilised across the European agricultural sector. Investment in more advanced tractors offering greater performance and simpler and easier operation and maintenance should see revenues rise in future years. All tractor product segments are expected to see greater growth, although the strongest rise is projected for four-wheel drive tractors where suppliers should benefit from the demand for higher-powered technology to take account of the increased size of farms and the increased complexity of activities.

Growth in the combine harvesters sector is expected to be reasonable over the course of the forecast period. Developments in this product area are expected to benefit from greater advances in the technology as well as a continuing need for replacement and upgrades as users attempt to improve productivity, performance and yields.

The European agricultural machinery market is served by a diverse range of manufacturers. However, following the increasing globalisation of business and stiffening competition, the market for agricultural machinery is undergoing major changes. A series of mergers and acquisitions have resulted in the market becoming increasingly dominated by a small total of large manufacturers that are able to offer a comprehensive product range on a global basis.

Other factors influencing competition within the European agricultural machinery market include the requirements for an efficient customer service and also the need to charge very competitive prices. The ability to offer a comprehensive customer service is essential to gaining repeat orders and building customer satisfaction and loyalty.

Additionally, following the negative trend towards lower prices of goods in the agricultural sector, price continues to be a major competitive factor in the machinery market, and the ability to offer flexible and customised pricing policies is a key means of product differentiation.

Frost & Sullivan is an international marketing consulting company that monitors a comprehensive spectrum of high-tech markets, including the machinery industry for market trends, market measurements and strategies. This ongoing research is utilised to complement a series of research publications - such as the European Packaging Machinery Market (3767) - to support industry participants with customised consulting needs.

Report Code: 3678. Publication Date: November 1999. Price: 3,950 Euros. Contact: **Frost & Sullivan, tel: +44 171 915 7824**

# Results from pesticides monitoring published

The annual report of the Working Party on Pesticide Residues (WPPR) was published today. It shows that over 98 per cent of foods tested in 1998 had residues below, the legal maximum residue limit (MRL).

Of the 2,187 food samples tested, 73 per cent had no detectable residues, 26 per cent contained residues below the MRL, and 1.3 per cent were found to have levels above MRLs. MRLs are not safety limits and none of the residues which exceeded the MRL were high enough to cause concern for consumer safety.

The monitoring programme covers the main food groups such as bread, milk and potatoes and also incorporates a range of fruit, vegetables, cereal products and animal products. The samples are purchased mainly from retailers throughout the United Kingdom.

The annual report includes brand name details on the samples analysed for the first time. A short summary leaflet, explaining the work of the WPPR and the main findings in 1998, is also available.

Professor Ian Shaw, Independent Chairman of the WPPR, said: 'These findings are reassuring with almost three quarters of the food samples tested being free from detectable residues. This is particularly pleasing when set against a background of the increasing number of individual tests being carried out on the food samples analysed. We will keep a close watch on any areas where standards are being breached, and ensure that all results are published. The extremely small proportion of samples which exceeded the legal limits did not contain residue levels causing harm to consumers. The results demonstrate clearly that residues in food are not a cause for concern.'

A sub-group of the Working Party is responsible for setting the annual monitoring programmes. The food tested and pesticides sought depends on the importance of the food in the diet and the likelihood of finding residues. Key findings of the 1998 monitoring programme are set out below.

**Milk** In 1998, for the first time in many years, no residues of lindane were detected in the milk. This followed an unexpected rise in the level of lindane in milk in 1995. As a result of this in 1996 and 1997 milk was tested on a monthly basis so that any further increase would be detected early.

**Infant food** Safeguarding the health of infants and children is a high priority for the Government and the Working Party. Regular monitoring of baby foods and foods popular with children is therefore carried out. In 1998, the survey of meat based infant food found no detectable pesticide residues. A survey was also carried out on fruit and vegetable based infant food with low level residues detected in 160% of the samples. None of the residues detected would be harmful to infants.

**Pears** Results for pears have already been published (Food Safety Information Bulletin July 1999). Residues of chlormequat in imported pears were found above the statutory maximum residue level. Residues were also detected in some UK pears which suggests non-approved use of this pesticide as it is not permitted for use in the UK on fruiting pear trees.

The Government are currently monitoring pears on a monthly basis for this pesticide and will publish results from the first six months of the 1999 pear survey later this year. As a result of these findings an enforcement programme has commenced on both UK and imported pears. This will allow legal action to be taken on growers/retailers who sell pears found to contain non-approved levels of chlormequat. Additionally representations have been made to the Belgian and Dutch authorities to tighten controls on exported pears.

**Winter lettuce** Over the last few years the Working Party has reported that a small minority of UK lettuce growers were using illegal pesticides on their crops. MAFF's enforcement programme has so far resulted in five successful prosecutions for illegal use of a pesticide on winter lettuce. The 1998/99 enforcement campaign saw, an improvement; only two residues were found which an illegal use and these are currently being investigated further. The Working Party also tested winter lettuces from retailers in 1998. Nearly half of these lettuces were found to contain residues which either exceeded the MRL or contained a non-approved pesticide. None of the residues found presented a health risk to consumers. The Government will continue to keep the level of residues in winter lettuce under close review.

**Yams** - the Working_Party also includes foods which are significant in ethnic diets. In 1998 yams were surveyed. A majority of the samples tested were found to exceed the MRL. The pesticides found were used to treat the yams following harvest. Most of the residues will therefore be on the skin of the yams. A risk assessment was carried out on the levels found and none were a consumer health risk. The MRL for yams is currently set very low- i.e. effectively a 'no residue' level. This reflects the fact that there has been no application to the European Commission to set a maximum residue level for this crop. The exporting countries have been informed of these results and will be encouraged to apply for an MRL within the EU. The Working Party intends to monitor yams again.

Contact: **Call 01904 455775 for information from the Pesticides Safety Directorate** about pesticide residues in food. The Annual Report and the brand name Annex are available on the PSD web site http://www.maff.gov.uk/aboutmaf/agency/psd/psdhome.htm. It is also available free of charge from MAFF publications, PB No. 4546 by writing to ADMAIL 6000, London SWIA 2XX. The short summary leaflet is also available, from the Pesticides Safety Directorate, tel: 01904 455756 or write to Room 312, Mallard House, Kings Pool, 3 Peasholme Green, York YO1 7PX.


Typical Finnish logtransporter with trailer and loader, and a total weight of 60 t.

# Computers in planning and control of timber procurement

**Mikko Välikoski**

*This paper was presented at the 1st International Conference on Forestry Engineering entitled: 'Forestry Engineering for Tomorrow', organised by the Forestry Engineering Group of the IAgrE and held at the University of Edinburgh, Scotland, UK on 28–30 June 1999.*

*Forest engineer Mikko Välikoski is employed by Metsäliitto as a District Manager since 1996, and previously was Head of Metsaliitto´s transport logistic project and it´s development.*

In this article, I shall describe some of the most important applications of information technology, as used in our company´s timber procurement. The examples that I have chosen are the hand-held computers used by field supervisors, our planning and control system for timber procurement, and mapping system for harvesting and transport.

Computers are used at almost every stage of timber procurement. Aside from normal office computers, information technology is used in the forest for collecting data on stands and conditions; it is also used in timber transport vehicles, harvesters, forwarders, and in measuring manually felled timber.

Hand-held computers have been standard equipment for field supervisors for ten years. Initially, they were used in forestry planning to collect data on stands and conditions in different management units and in measuring the volumes of logs cut. Loggers too, have been measuring volumes of felled timber electronically for several years.

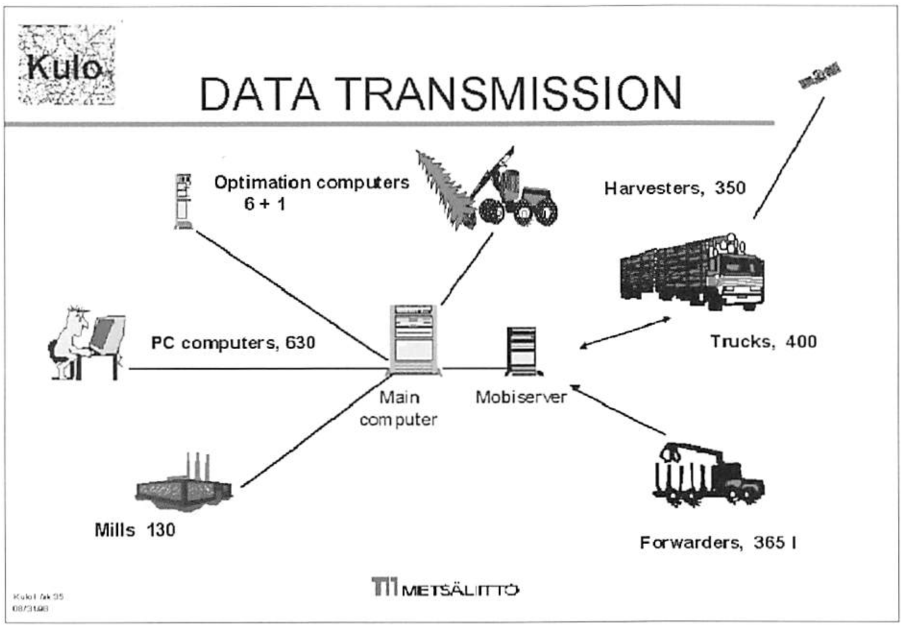
Computers have been used in harvesters for operation and measurement almost since the first harvesters appeared on the scene. Mapping systems, timber measurement, and log cutting plans have made computers standard equipment in harvesters.

Progress during the past couple of years has been fastest in the use of mapping applications. Metsäliitto uses mapping systems in timber harvesting and transport, and also in planning forest management and utilization.

The planning and control systems for Metsöliitto´s entire timber procurement operations is based on the use of site data. Mapping systems can be used to find the right geographical location for wood supply and demand, which are used for optimization calculations

I should point out here that our company procures almost all of its raw timber material from private forest owners, whether in the form of delivered logs or as standing reserves.

The planning and control system is based on three different time periods: Annual planning, monthly schedules and daily transport control. In the first stage, we determine the geographical location for wood procurement, and make




**Metsaliitto´s wood procurement data network system with total number of units.**

preliminary decisions on the use of different forms of transport, which are road, rail and floating.

Monthly schedules are based on work schedules for harvesters and on data relating to the intended locations of timber stockpiles. It is from this stage that we obtain the transport schedules, which show the destination (mill) and each consignment´s estimated time of arrival (ETA).

The most interesting stage, but the most demanding one in terms of computer technology, is control of the daily transportation. The primary goals here are to satisfy the mills´ raw material needs and make efficent use of transport resources. The Metsäliitto system comprises six control centres in different parts of Finland. Each centre controls from 50 to 70 transport vehicles. Control is based on data on the locations of timber stockpiles and on information from forwarders on timber volumes arriving at stockpiles. The optimization programme is used to generate transport schedules for each vehicle for the following day. The transport schedule is sent to the vehicle´s computer using data transmission.

## Brief outline of mapping systems

*Mapping system used by a field supervisor when purchasing timber*

Having signed a felling contract with the sellers, the field supervisor uses the information system to record the number of stands marked for felling, and the quality of the timber in them. Using the graphical user interface, he also marks on the map all site data needed for harvesting and transport. Such data includes the boundaries of areas marked for felling, stockpile locations, access route, points of enviromental importance that have to be avoided, and the right of use of certain roads. In addition to the usual basic information, digital map material includes real estate boundaries and contour lines. Data entered by the field supervisor is used, together with that on stands, to choose suitable felling areas for each particular timber requirement. The next step is to produce a detailed schedule for each harvester, usually one month ahead.

**Driver's cab equipped with a computer and data transfer system.**

*Mapping system for planning harvesting*

The mapping system used for planning timber harvesting is based on data recorded at the time of purchase. The monitor displays a map onto which favourable harvesting areas are highlighted. The felling areas are selected for each harvester´s working schedule by clicking them with the mouse.

Information on each felling site, including estimated timber volumes, log sizes and the nature of the terrain, can be displayed in a separate window. As felling sites are selected for the schedule, the volumes of each type of timber are displayed as they accumulate. The final schedule can be sent to the harvester´s mapping programme by data transmission. Other information needed during harvesting, such as desired sawlog dimensions, can be sent at the same time.

As felling proceeds, the forwarders use their own data transmission equipment, to report the volumes of timber, taken daily to the stockpiles, for use in the transport control system.

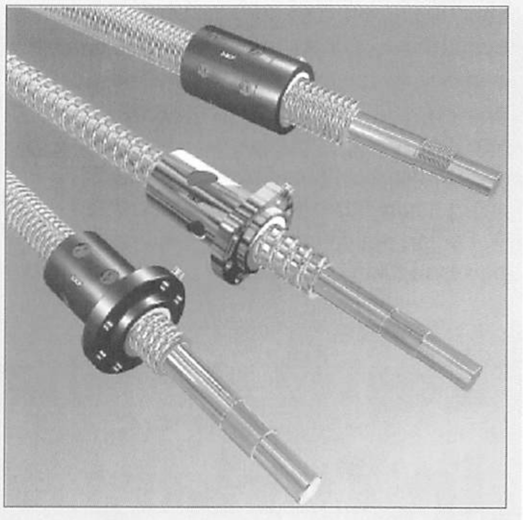
*Mapping system for transport vehicles*

The map on the monitor screen shows the drivers the location of the logs to be collected, and gives them an approximate schedule. Using the GPS instrument, the drivers also know their own position on the map. Via the mapping programme, the driver reports to the company's information system on completion of each delivery.

When the drivers switch on the computer in the morning, they automatically receive the day's transport schedule, showing the location of the timber to be collected, the volumes to be transported, approximate arrival time at the mill, distances between stockpiles, *etc*. The driver chooses the first consignment from the programme. The computer will then automatically select a map scale that shows the positions of both the vehicle and the timber awaiting collection. The map detail is increased automatically as the vehicle approaches the timber in question. Having loaded their vehicles, the drivers report the volume of wood loaded and the volume remaining at the stockpile, to the company's information system.

# SKF provides cost-effective solution to precision ground ballscrew drive systems

With a screw diameter from 16 mm to 125 mm and leads between 5 mm and 50 mm, SKF can supply a full complement of precision ground ballscrews and end bearing assemblies of the highest quality at the most cost-effective price. This capability is due to a huge investment in manufacturing plant and improved processes such as heat treatment and inspection facilities.



SKF's world lead in ballscrew production complements its position in the bearing industry. Making up the range of screws in lead precision grades ISO 1, ISO 3 and ISO 5 is the availability of a selection of nut types: DIN standard 'PGFJ' flanged nut with internal preload; 'PGFL,' double preloaded flanged nut; 'PGFE' double preloaded flange nut to DIN standard; and 'PGCL' cylindrical double preloaded nut.

In addition, an array of standard machined ends can be specified along with a selection of end bearings. The 'FLBU' flanged bearing can be specified with axially located flange housing, using SKF angular contact ball bearings in standard or thrust format with sealed for life lubrication and matched bearings. The 'PLBU' plummer housing or axial free plummer housing utilises SKF's deep-groove ball bearings.

Operating temperature for SKF ballscrew assemblies range from -200°C to 1000°C. However, for temperatures in excess of 1000°C, SKF's Engineering Products application team can specify special steels and lubrication.

The PGFJ flanged nut with internal preload is available for screw diameters from 16 mm to 80 mm with a choice of either 5 mm or 10 mm lead. The number of ball circuits can be specified as 3 by 2 or 4 by 2, and dynamic load ratings vary between 9.7 kN and 77.5 kN.

For the PGFL double preloaded flange nut, which can accommodate shaft sizes between 16 mm and 125 mm, diameter load can be specified between 5 mm and 50 mm and up to 269 kN dynamic load rating with the number of ball circuits between 1.75 and six. The PGFE double preloaded flange nut to DIN standard is available with up to 269 kN dynamic load rating between 16 mm and 125 mm diameter and leads of 5 mm, 10 mm or 20 mm with between three and four ball circuits.

Meanwhile, the PGCL cylindrical double preloaded nut can accommodate shaft sizes between 16 mm and 125 mm having leads between 2 mm and 30 mm with three, four or six ball circuits and dynamic loading up to 269 kN.

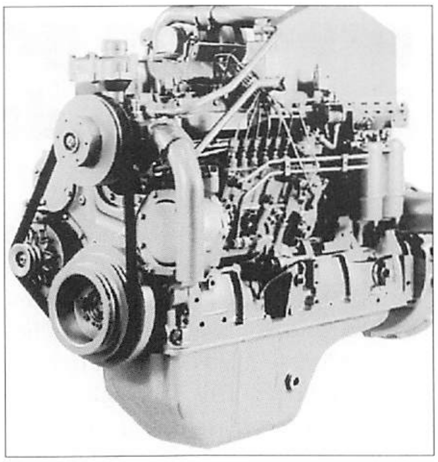
Contact: The new SKF web site which incorporates all the latest SKF product and press release information is: **http://www.skf.co.uk** or Tel: **Andy Pettican, Business Development, 01582 490049**

# Valmet forestry machines benefit from new diesel technology

Sisu Diesel (formerly Valmet Diesel and now a Partek Company) has made a number of developmental changes to its engine range. These make the current models the 'cleanest' in emission terms ever offered by the company. These latest developments need to be measured against existing engines produced by the company. These were already among 'best in class' relative to output and application.

All Valmet forestry equipment will be powered by these latest generation 'environmental' engines. The Valmet 820 and 901 are fitted with a Sisu four cylinder 420 DWRE, the larger Valmet 840 S-2 being powered by the more powerful 420 DWRIE Intercooled version.

The Valmet 860, 890 and 911 use the six-cylinder 620 DWRE, with the Valmet 921 being fitted with the larger and more powerful 634 DWBIE engine. This unit



has a swept volume of 7.4 litres.

All engines use replaceable wet cylinder liners and benefit from crossflow cylinder head designs for maximum efficiency. High-pressure fuel injection systems ensure maximum fuel atomisation for a clean burn and reduced hydro carbon and NOX emissions. The latest engines meet, or surpass, all requirements imposed by the European and American authorities 97/68/EC and 4OCFR 89 EPA for off road vehicles.

Sisu Diesel has 50 years of experience in diesel engine design and production. The company's engines have a reputation for producing high torque at low revs, ideally suiting them to forestry and agricultural applications.

In forestry machines, the engines can be run at a modest 1200 - 1600 rpm. This reduces noise, vibration and fuel consumption and is also a key factor in the engines' reputation for longevity, reliability and economy.

Contact: **Kenny Paterson, Partek Forest Ltd, Longtown Industrial Estate, Longtown, Cumbria, CA6 5TJ. Tel: 01228 792018. E-mail: Partek@globalnet.co.uk**

# Joint venture tractor company in Turkey

Deere & Company and the Hattat Group of Turkey have agreed to form a joint venture company for the production of 38 kW to 60 kW tractors and the distribution of John Deere agricultural equipment throughout Turkey. Deere & Company will own the majority interest in the newly formed corporation, to be called John Deere Hattat AS.

This agreement includes the establishment of a factory for the production of tractors under 75 kW and related components in Cerkezköy, 56 miles west of Istanbul, and the development of a dealer network providing service and spare parts for John Deere agricultural machinery. The factory will become operational early in 2001. Further terms of the agreement were not disclosed.

With this agreement, John Deere emphasises the role of Turkey as a key agricultural machinery market in the world. 'Our manufacturing presence in Turkey will be another important step in extending John Deere's pre-eminent position in the agricultural equipment business around the world,' said Robert W Lane, Deere & Company senior vice president and managing director for Europe, Africa and the Middle East.

'The Hattat Group, with which we have enjoyed a long-standing business relationship as a supplier of hydraulic components to John Deere factories in several countries, gives us a reliable and experienced partner in pursuit of Deere's strategy for profitable growth, while helping us to improve the productivity of farmers in Turkey.'

Mehmet Hattat, chief executive officer of the Hattat Group of Companies, added: 'At the threshold of a new millennium, we are delighted to expand our relationship with Deere & Company in order to combine John Deere's 162 year technical know-how in equipment manufacturing with the Hattat Group's proven expertise as a key supplier to the off-road OEM equipment industry.'

Deere & Company, with more than 37,000 employees worldwide, produces a broad range of agricultural equipment, construction equipment and commercial & consumer products, manufactures in 11 countries and markets products in more than 160 countries. The company also provides financial services for businesses and the general public.

With more than 1000 employees, the Hattat Group of Companies is a major supplier of hydraulic and mechanical components for the OEM industry, manufactured according to the ISO 9001 quality standard under the name of HEMA.

Contact: **Alec McKee, Managing Director, John Deere Ltd, Langar Nottingham NG13 9HT. Tel: 01949 860491**

# John Deere combines improved for 2000

John Deere's flagship CTS combine harvester features a number of improvements for 2000, designed to further increase operator comfort and productivity, especially in difficult conditions and when working early in the morning or late at night. The main change is the introduction of a new CommandTouch cab, with ergonomic controls, revised instrumentation and a new air suspension seat.

The new CTC master control lever has an adjustable hand rest and convenient switch locations for the ContourMaster automatic header float and stubble height, unloading auger and 'quick stop' controls. This lever is part of the CTC console, which is incorporated into the seat's armrest. The console provides fingertip control of a multitude of combine functions, with switches backlit for easy, safe operation at night. All settings are automatically displayed on the combine's InfoTrak monitor when adjustments are made.

The cab's new corner post has three displays for all the main combine functions - the header monitor, the VisionTrak performance monitor and the InfoTrak function monitor. It also features the ContourMaster control display panel. Further improvements include an accurate laser tailings monitor with automatic calibration and built-in diagnostics, ClimaTrak automatic air conditioning and a new CAN BUS electrical system. This uses fewer cables and connectors to provide faster, more reliable transmission of information to the operator.

There is also a larger, 570 litre fuel tank, more powerful infra red lights to make night working easier, and a new clean grain elevator with 20 per cent extra capacity, claimed to be the biggest elevator on the market.

New options include in-cab electrical adjustment of the straw chopper deflector, and a field office storage compartment located underneath the cab's spare training seat, which is exclusive to John Deere.

The CTS combine features a cylinder tine separation system, which is at the heart of the machine's innovative threshing design. In operation, a thin, uniform crop mat is delivered at a shallow angle to the cylinder/concave area, where up to 90 per cent of the crop is separated. From here the crop moves quickly across an eight wing beater to two counter rotating tine cylinders that run the length of the combine, at right angles to the main cylinder and beater, with a total separation area of 2 $m^2$. The 'pull and release' action of the CTS tine cylinders works with the centrifugal force to free any grain trapped in the straw as the crop mat moves towards the rear of the combine. The heavy duty tines comb gently through the crop, keeping the straw fluffed, not flattened. This helps to maintain a smooth flow of material even in wet conditions, and leads to faster, cleaner grain separation with fewer losses.

The CTS combine is equipped with a John Deere 8.1 litre PowerTech diesel engine, hydrostatic drive and a three speed transmission. The turbocharged six cylinder engine develops a rated 229 kW, or 248 kW maximum power under load at 2100 rpm. This extra power is provided when the combine is working in more difficult conditions, such as a thick, moist or weedy crop. When unloading the massive 9500 litre grain tank, the engine produces a further power boost to 274 kW, which allows the tank to be emptied in two minutes on the move.

Basic price of the new John Deere CTS combine for 2000 is £163,312 with a 6.7 m header, or £164,412 with a 7.6 m header, including ContourMaster and straw chopper as standard.

John Deere's 2200 Series combines have also been improved for the 2000 harvest season. The six walker 2264, 2266 and 2266E models now include stronger front and rear axles, giving higher load carrying capacity for heavy front end equipment, while the five walker 2254, 2256 and 2258 models benefit from the reinforced rear axle.

In addition, all 800 and 900 Series headers from 4.2 to 7.6 m, to fit 2200 Series and CTS combines respectively, now come as standard with full width retractable fingers for increased performance in green straw and damp conditions.

John Deere Credit is offering 0% finance on all new John Deere combines for next season. Customers need pay nothing until March 2000, and can then make three equal annual payments, interest free, based on 60 per cent of the retail price. Full details of the scheme are available on request from John Deere Credit on 01452 375182.

Contact: **David Hart, John Deere Ltd, Langar, Nottingham, NG13 9HT. Tel: 01949 860491**

# Branch Diary

## Scottish Branch

All meetings start at 7.30 pm. Non-members welcome. For further details contact the Honorary Secretary.

### Wednesday, 16 February 2000

Venue: King Robert Hotel, Stirling
*Members' Night and Annual General Meeting*

### Tuesday, 9 May 2000

Venue: Stakis Hotel, Edinburgh Airport
***National Conference***
*Food for thought*

*Hon Sec: Mr G M Owen Tel: 01968 675943*

## Wrekin Branch

All meetings start at 7.30 pm. Venue: Harper Adams University College, Edgmond, Newport, Shropshire. Meetings are open; members are welcome to bring guests. For further details contact the Honorary Secretary.

### Monday, 17 January 2000

*Electricity in agriculture*
Speaker: Farm Energy Centre representative
(Joint meeting with IEE)

### Monday, 14 February 2000

*Engineering research at Harper Adams University College*
Speaker: to be announced

### Monday, 6 March 2000

*Annual General Meeting* followed by *Engineering for animal welfare*
Speaker: Alastair Taylor, Branch Chairman and Reaseheath College

### Monday, 20 March 2000

*Cossacks on combines*
Speaker: R Cornes, Training Manager (retired), Case UK
The trials and tribulations of providing service support staff for combine harvesters in the former Soviet Union countries

*Hon Sec: Denis Cartmel Tel: 01785 712690*
*E-mail: dcartmel@forgecomm.freeserve.co.uk*

## West Midlands Branch

For further details contact the Honorary Secretary. Location plans are available on request. You are advised to confirm the details on the day, especially if travelling a long way.
All meetings are at 7.30 pm unless highlighted.

### Monday, 10 January 2000

Venue: Evesham College
*Development of the MF combine harvester*
Speaker: James Wallace, ex-MF (services retained)

### Monday, 14 February 2000

Venue: MF AGCO Ltd., (Massey Ferguson), Banner Lane, Coventry
*Future agricultural power transmissions*
Speaker: Mike Savage, Manager, Off-Highway Engineering, Ricardo MTC Ltd

### Monday, 3 April 2000

Venue: Arthur Rank Centre, NAC, Stoneleigh
*Small scale biomass heating in the UK*
Speaker: Peter Telsen , Telsen Products Ltd

### Thursday, 13 April 2000

Venue: AGCO Ltd., (Massey Ferguson), Banner Lane, Coventry
*Precision farming for engineers*
Speaker: Mike Looney, Project Engineer
(A joint meeting with the Institution of Mechanical Engineers)

### Saturday, 10 June 2000 at 2.00 pm

*Visit to Ironbridge Gorge Museum*
Speaker: John Challen
Numbers are restricted; please pre-book with Branch Secretary

*Hon Sec: M C Sheldon Tel: 01926 318333*

## South East Midlands Branch

For further details contact the Social/ Visits Secretary. Some events require pre-booking. All meetings are at 7.30 pm unless highlighted.

### Monday, 10 January 2000 at 7.00 pm

Venue: Silsoe College, lecture theatre
***Various Research Papers:***
*How to ask chickens about transport stressors*
by Soibhan Abeyesinghe
*Intelligent control of complex soil tillage machinery*
by Darren Bentley
*Modified atmosphere packaging of minimally processed pineapples* by Agnes Budu
*Dirty water treatment using overland flow*
by Samantha Fleming
*Herbicide losses from engineered surfaces – management practices/impacts* by Antony Shepherd
*Matric potential and earthworm burrowing ability*
by Robert Stovold
Speakers: Silsoe College and Silsoe Research Institute

### Monday, 7 February 2000

Venue: Silsoe Research Institute, conference room
*Poultry processing*
Speaker: David Barker, Stork PMT UK Ltd

### Monday, 6 March 2000 at 7.00 pm

Venue: Silsoe College, lecture theatre
*Annual General Meeting* followed by *Climate change*
Speaker: Mathew Collins, The Hadley Centre for Climate Prediction and Research

**Monday, 17 April 2000**
Venue: Silsoe Research Institute, conference room
*Engineering aspects of precision farming*
Speakers: Mark Moore, AGCO; Adrian Hipwell, Farmade Ltd
(Joint meeting with IEE and IMechE)

**Week Beginning 26 April 2000**
Date and venue to be announced
*Visit to a poultry processing plant*
(Follow up of talk on 7 February 2000)
Contact Social Secretary by 12 April 2000

**Saturday, 17 June 2000** at 7.00 pm
*Barbecue*
Contact Social Secretary by 12 June 2000

*Social/ Events Sec: Chris Saunders Tel: 01525 863000*
*E-mail: c.saunders@cranfield.ac.uk*

## Southern Branch

For further details contact the Honorary Secretary. All meetings are at 7.30 pm unless highlighted.

**Thursday, 17 February 2000**
Venue: Sparsholt College, Winchester, Hants
*Engineering aspects of the production of a new range of potato harvesters*
Speaker: Philip Bosworth, Richard Pearson Ltd.

**Wednesday, 8 March 2000** at 7.00 pm
Venue: The Bunk, Curridge, Newbury, Berkshire
*Annual General Meeting and Dinner*
Members, partners and guests are particularly welcome on this evening

**Wednesday, 12 April 2000**
Venue: Rycotewood College
*Data Logging – Engine to the ground*

**Sunday, 4 June 2000**
Venue: Weald and Downland Open Air Museum, Singleton, Chichester, Sussex
*Heavy Horse Show Summer Spectacular*
Details to be confirmed

*Hon Sec: O J H Statham Tel: 01865 782259*

## Northern Ireland Branch

For further details contact the Honorary Secretary.

**Tuesday, 18 January 2000** at 8.00pm
Venue: Cohannon Inn, Dungannon
*Low ground pressure slurry systems*
Speakers: Michael Millar, Redrock Engineering and Richard Fitzpatrick, SlurryKat

**Tuesday, 24 February 2000** at 12.30 pm
*Annual General Meeting, Millennium Conference and 21st Anniversary Dinner*
A number of speakers will address the changing trends in agricultural machinery, buildings and engineering

**Thursday, 16 March 2000** at 2.30pm
*Visit to Gilfresh Produce, Loughgall – tour of the new vegetable packhouse and equipment*

*Hon Sec: John Mawhinney*
*E-mail: john.mawhinney@nireland.com*

## Horticultural Engineering Group

**Wednesday, 15 March 2000**
Venue: Silsoe Research institute, whole day event
*Into the 21st century*
Automatic harvesting of delicate horticultural crops
Robotics for harvesting for mushrooms
Mechanical weeding in row crops
Autonomous vehicle for field work in row crops
Crop environments
Crop spraying in glasshouses
The importance of physical and mechanical factors on glasshouse ventilation.

*Info Officer: G E Lawson*

## CAREERS information

Promote our industry as a career path worthy of consideration. What are job prospects in agricultural engineering? What are the routes to success? Where are the Colleges and Universities offering courses? Are commercial companies interested in the educational and training activities and project work? If you know of someone asking these questions, remind them that excellent careers literature provides the answers - and much more besides.

General careers literature is available from the Institution Secretariat. It includes wall charts and career briefs, all presented in an attractive, easy to follow layout, contact: **The Secretary, Institution of Agricultural Engineers, West End Road, Silsoe, Bedford. Tel: 01525 861096**

A Careers Brochure called *Rough Terrain Engineering* has also been published by Harper Adams and contains both general information on job opportunities, as well as more specific details on their degree course structure, contact: **Harper Adams University College, Newport, Shropshire TF10 8NB. Tel: 01952 815289**