AGRICULTURE ▪ HORTICULTURE ▪ FORESTRY ▪ ENVIRONMENT ▪ AMENITY

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Landwards

THE TRACTOR
BEGINNING OF THE END?

In this issue

- ***Automated Innovation Conference***
- ***AGRI-EPI Centre Event***
- ***Trailblazer Apprenticeships***
- ***BGAJ/IAgrE Journalists Award***
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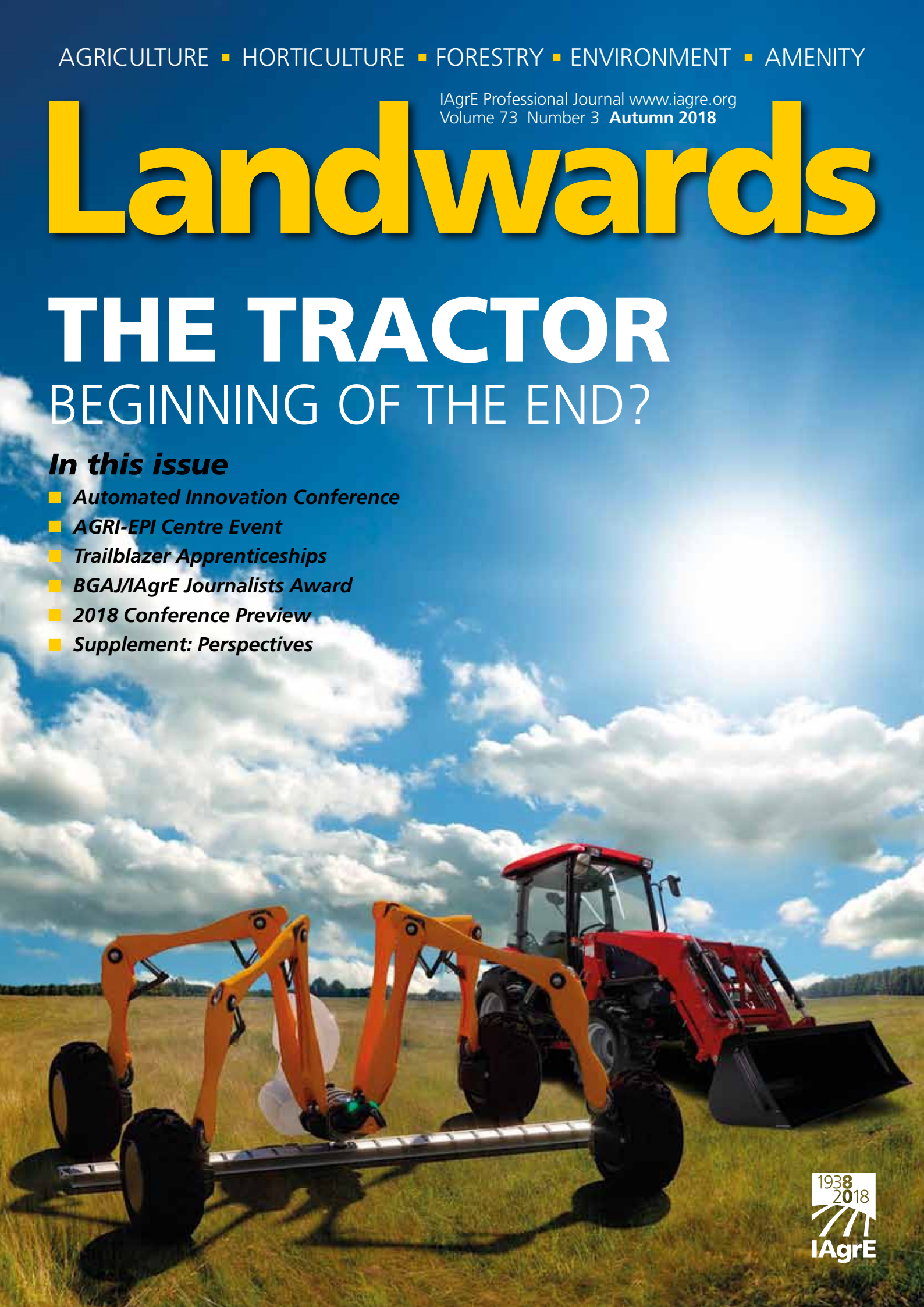

TECHNICIAN GRADE

NEW ROUTE INTO IAgrE FAMILY

The recently introduced Technician grade of IAgrE Membership is for those who are qualified at a vocational or technical level and have completed an apprenticeship or extended diploma.

To qualify, you will be working in the industry and will have built early experience and career development in the workplace.

You will also be keen to be part of the IAgrE family and seeking a cost-effective way of getting involved and benefiting.

The IAgrE Technician Grade may include

- Farm machinery service engineers with manufacturers, suppliers or dealers
- Those people working in precision farming
- Those working in soil science as technicians, instructors and trainers.

IAgrE Technician members will have a technical qualification in agricultural engineering, land-based technology or related engineering or scientific subject at Level 2 and above.
This will include, for example, an extended diploma, advanced apprenticeship or equivalent in an appropriate subject.

To apply or find out more:
Go to the IAgrE website and complete the Application Form and Guidance Notes. With your completed application form, you will also need to provide a current full and detailed CV which describes in detail your working history and experience. We will need copies of academic certificates and details of education/training.

For further information contact Alison membership@iagre.org or 01234 750 876

EDITORIAL: AUTOMATED TRACTORS - THEN

Rather provocatively perhaps, this issue of Landwards questions whether the days of the tractor (as we know it) are numbered? The answer of course is, highly unlikely. The more relevant question is, are we reaching the end of the quest for producing bigger, heavier and more powerful tractors? And here the evidence points to a more compelling answer of yes probably.
There is little doubt that we are now seeing practical examples of automated farming systems emerging across the globe. Many are niche products, small scale operations, but once the dam bursts I can see a rapid take-up within ten years, twenty years?
The First Automated Innovation Conference at Harper Adams was buzzing with new ideas, enthusiasm, out-of-the-box thinking and practical examples (gin made from grain harvested yards from the door, the growing unsullied by human hand. I'll drink to that!)
The gestation of new technology is dependent on many factors. Extensive trialling, money and the willingness to adopt by the end-user.

All of which took me back to my first experience with an automated tractor - 56 years ago!
I was a rookie demonstrator in 1962 with Ford Tractors based at the blessed Boreham House near Chelmsford. The demonstration team ran a series of Farming Fairs across the UK and Europe, amongst which was a seven-month trip round Spain. It was like being in a circus. We erected floodlights, a cinema tent, stands and even had our own firework maker to provide a show at the end of each weekend event.
Our *piece de resistance* was a radio controlled Fordson Super Dexta with mounted 3-furrow reversible plough. Our tour leader, Arthur Battelle, would stand proudly in a Fordson crested blazer with a control box and aerial slung round his neck, giving ploughing demonstrations to farmers of this 'driverless tractor'. Unfortunately, the Spanish sun was often not kind to the controls and the tractor and plough sometimes had a mind of its own. In Toledo during a pre-event promotion it attracted a huge crowd as it trundled through the narrow streets – us not knowing if the reversible plough would flip over unannounced, wiping out several locals! Although something of a gimmick, it was the forerunner of much of the development today.
I recorded the tractor at work and the tour on an 8mm cine-camera which I've just had converted to MP4 format so hopefully will be able to share the (rather grainy) footage with you shortly.

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AGRI-EPI CENTRE STAKEHOLDER DAY

Opportunity to update on progress Report by Marion King

The Agri-EPI Centre stakeholder day is an annual event designed to bring together core partners and update them on the Centre's progress. Over 60 members from the wider agri-food industry took part in the event that gave members the opportunity to get to know other organisations and build new alliances.

This year the day was hosted by Cranfield University, one of the Agri-EPI Centre hubs and home of the Plant Phenotyping and Soil Health Facility.

Professor Leon Terry, director of Environment and Agrifood at Cranfield University, opened the event and gave an overview of the Agri-Epi's Remote Sensing and Precision Agriculture technology at Cranfield.

Professor Terry was followed by Dave Ross, chief executive officer of the Agri-EPI Centre who gave an up-date on the developments within the organisation over the last year, the international links that are built to support the members and the expected opportunities in the near future.

The Knowledge Transfer Network and Innovate UK talked about important upcoming grant funding opportunities in both the UK and Europe.

The Industrial Strategy Challenge Fund is part of government's Industrial Strategy, with a long-term plan to raise productivity and earning power in the UK. Representatives from the United Kingdom Research and Innovation (UKRI) told the audience about the forthcoming £90m funding via the Industrial Strategy Challenge, called 'Transforming Food Production.'

The fund is a core pillar in the government's commitment to increase funding in research and development by £4.7 billion over 4 years to strengthen UK science and business.

The Agri-EPI Centre can assist members with applications by helping them understand what funding is available, getting ideas on paper, connecting with relevant partners and making Agri-EPI facilities and equipment available.

There was also a section where members had 10 minutes to introduce their organisation to the group. Examples are Mark Jarman, Head of Earth Observation and a Satellite Application Catapult, Professor Paul Miller promoting the work of the Douglas Bomford Trust and Max Dafforn general manager of IPF an independent precision service provider.

The day ended with a tour of the state-of-the-art agri-tech facilities including the glasshouse vehicle, mobile sensor equipment, the instrumented farms for data collection, post-harvest storage facilities and the informatics data hub.

REASEHEATH SECURES £15m FUNDING

Deal finalised with Santander

Nantwich-based Reaseheath College has secured a £15 million funding facility from the education division at Santander Corporate and Commercial.

The deal will help the college increase the number of courses it offers, expand student accommodation and grow the college's reputation nationally and internationally.

The funding was provided following an initial refinancing package of £14.5 million in 2017.

The college has also transferred its full banking relationship to Santander.

Graeme Lavery, chief finance officer and director of resources at Reaseheath, said: "Reaseheath College have been delighted with the support provided by Santander to date.

"The series of new capital developments that we have underway are important for the ongoing success of the college in providing high quality facilities for our learners and employer partners with whom we work in equipping students for their future careers."

John Ramsay, relationship director of education team at Santander, said: "We are delighted to be able to support Reaseheath College with this funding and look forward to supporting the college to achieve its goal of expanding both nationally and internationally"

RESEARCH PROJECT FOR AGRI-EPI CENTRE

TAFE tractors take up residence

Harper Adams University (HAU) has entered a new international collaboration with India-based Tractors and Farm Equipment (TAFE) to develop advanced technological, agronomic and educational solutions for the delivery of sustainable food production around the world.

TAFE, the world's third largest tractor manufacturing company in terms of volume, has become the first business to take up residence in the Agri-EPI Centre Newport Hub, on the university campus, to commence a major, collaborative research and development project.

Agri-EPI Centre is one of the four national Centres for Agricultural Innovation created as part of the £17.7m UK government investment from the UK's Strategy for Agricultural Technologies to help provide engineering and precision agriculture solutions for the agri-food industry. The collaboration between TAFE, HAU and Agri-EPI will include joint research projects and programmes, joint publications and staff exchanges.

Research will be focused on agriculture, engineering and technology development programmes on autonomous farming and energy efficient implements, Unmanned Aerial Systems (UAS) and sensor technologies along with the Hands Free Hectare (HFH) project that will be implemented at JFarm India; TAFE's adaptive agriculture research centre.

TAFE President & COO, Mr T R Kesavan said: "TAFE's collaboration with Harper Adams and the Agri-EPI Centre is a reaffirmation of TAFE's commitment to its vision of 'Cultivating the World' as it aims to combine integrated farming techniques with precision agriculture and engineering to develop sustainable farming models that work for both marginal and large farms.

"This collaboration will provide opportunities for developing a range of advanced training skills, learning and the promotion of international technology transfer and exchange."

On the team's arrival, Harper Adams Agricultural Engineering Lecturer Kit Franklin said: "We at Harper Adams have been building contacts with TAFE for the last 18 months.

"It's great to now have this young and enthusiastic team of engineers from TAFE's Centre of Excellence here in the UK, where we're about to start on our first collaborative engineering project.

"Along with the completion of the project, I hope the team will get a flavour of British agriculture, helping them to return with fresh new ideas."

Welcoming them to the Agri-EPI Centre, Lee Williams, Newport Centre Hub Manager, said: "We're extremely excited about the first major R&D project coming into the centre but even more so as it's a large international tractor manufacturer that's working in collaboration with Harper Adams."

INCREASED PARTICIPATION IN JOHN DEERE'S APPRENTICE PROGRAMMES

54 young service technicians are being trained

A total of 54 young service technicians are being trained in this year's John Deere Ag Tech, Parts Tech and Turf Tech advanced apprenticeship programmes, run in partnership with national training provider ProVQ – an increase of just over 60 per cent on the previous year's intake.

John Deere has also been listed for the second consecutive time in 2018 as one of the best 100 employers for school leavers in the UK, the only agricultural and turf machinery company to be so recognised. The AllAboutSchoolLeavers.co.uk's Top 100 Employers for School & College Leavers rankings are based entirely on the opinions of apprentices and school leaver trainees from hundreds of UK organisations.

John Deere's and ProVQ's successive annual awards were made in recognition of their programmes' quality and the opportunities they present to young people working productively in the agricultural and turf sectors.

"We have beaten some very strong competition from other household names, coming first for an engineering and manufacturing company and third overall in the Best Intermediate Apprenticeship Programme category in 2017," said ProVQ managing director Julian Lloyd.

"We've also been recognised in the Advanced Apprenticeships and Engineering categories this year. To be recognised as one of the country's top 100 employers for school leavers, as judged by the apprentices themselves, makes us all very proud of our achievements."

Now in its 26th year, Ag Tech was the first such scheme to be introduced in the UK and won a National Training Award at the end of 1997, the only one ever made to an agricultural machinery apprenticeship programme. Since the first programme started in 1992, well over 700 apprentices have graduated through the three main schemes and are now working in the company's nationwide dealer network.

HARPER ADAMS PARTNER WITH CHINESE DRONE MANUFACTURER

Presents high specification drone to NCPF

The National Centre for Precision Farming (NCPF) at Harper Adams University and XAG, one of the world's largest drone and robot company, have recently formed a strategic academic and research partnership.

XAG, a Chinese company which was founded in 2007, focuses on agricultural automation and research and development of unmanned devices. XAG is one of the world's largest agricultural drone manufacturers with a large-scale manufacturing and operational centre in China.

Over a period of 12 months XAG crop-spraying drones have flown 1.7 million times in total, served more than 700,000 Chinese farmers covering two million hectares of land.

Justin Gong, Co-Founder and Vice President of XAG, said: "As the strategic partnership has been officially established, I am sincerely looking forward to the collaborations between XAG and Harper Adams University to develop localised drone and robotic solutions which suit the UK and European farmers.

"We hope our technology can equally serve UK and European farmers, to help them improve productivity using sensors mounted on the drones to monitor the condition of the crop and subsequently only applying the chemical precisely on area requiring treatment.

"In addition, we would like to devote more on researching about AI technologies and ground-based robots to free farmers' hands, also to accelerate the popularisation of drone application. With HAU's research strengths on agriculture and sustainable farming, I believe we can make the most of our potentials."

Parmjit Chima, Head of Engineering at Harper Adams, said: "It's great to see the university being recognised as a leader in agricultural drone and robotics technology by XAG in this mutually beneficial collaboration to develop new agri-tech solutions for farmers both at a national and international level."

Harper Adams Research Support and Project Lead, Debbie Heeks said: "At present, UK legislation does not permit the use of drones for crop spraying. However, Harper is working closely with the relevant authorities, such as CAA and others to enable trials involving drones for the first time in the country.

"At the recent Agricultural Innovation Conference and Exhibition, XAG donated a high specification agricultural spraying drone to Harper. The P20 2018 Plant Protection UAS, named Barbara, is a fully autonomous system. It was presented to us by Justin Gong, Bridge Liu and Walter Chen.

"It's a very clever system and it's very exciting that we have the opportunity to work with it and XAG. We hope that our work with the system will help strengthen the case for using crop spraying drones in the UK."

CITY & GUILDS MEDALS FOR EXCELLENCE

One industry, one college – two medals

Just 200 of the prestigious City & Guilds Medals for Excellence are awarded worldwide each year to students, lecturers and City & Guilds staff in recognition of exceptional work. They recognise not only excellent results but also reflect a true journey of progression throughout their qualification.

This year, two representatives of the landbased engineering sector, Luke Hill of Ernest Doe and Matt Davis of Kubota UK, have been awarded Medals of Excellence. Both have gained Level 2 Diplomas in Work-based Landbased Engineering (Groundcare) at the same college, Evesham College (part of the Warwickshire Colleges Group).

The medals were presented at Pershore College on 10 July 2018 during a special workshop on Apprenticeship Standards in Landbased Engineering organised by LE-TEC (Landbased Engineering Training and Education Committee Ltd).

Sally Green, City & Guilds Development Manager said, "It is very rare that two winners of our annual Medals for Excellence should come from the same industry sector, let alone the same college."

Luke Hill joined Ernest Doe, Bedington branch three years ago from school. Barry Prior, Groundscare Service Manager at Bedington said, "This is a thoroughly well-deserved Award. Although quietly spoken, Luke is a popular member of our team, absorbs information very well and has shown a tremendous willingness to learn. He is sure to make a first-rate fully-qualified technician".

Matt Davis originally went to University to study criminology with a view to joining the police. However, during his course he became somewhat unconvinced with his career choice and decided to look at alternative options. His father, Neil, is Service Director at Kubota dealership Lister Wilder Reading and he spent a few months in the dealership before taking up the offer of an apprenticeship in Kubota's Service and Training department.

Commenting, Matt said " I am extremely proud to have won this Award which recognises the hard work I've put into my Level 2 qualification. I've really enjoyed my experience as an apprentice and would like to express my thanks and gratitude to my tutor at Pershore, Darren Layton, for his expert guidance, teaching and passion for landbased service engineering. Being an apprentice has given me the foundation for a long and successful career - and the opportunity to be earning whilst learning."

Luke Hill (second left) pictured with Sally Green (City & Guilds) and Mark Eden (Warwickshire Colleges)

Matt Davis (right) pictured with (l to r) Martin Tyler (Kubota), Sally Green (City & Guilds) and Mike Bywater (Kubota)

CEO

Reflections on a changing world

STEREOTYPICAL ENGINEERS?

The challenges of 'unconscious bias'

Alastair Taylor *IEng CEnv MIAgrE*

Listen to the news and you will no doubt have noted that the subject of Equality and Diversity is at the top of the agenda. The same goes for the Engineering Community with a broad range of activities which seek to widen participation from underrepresented groups. What's not to like about this?

I have always found the subject of widening participation interesting and in previous job roles, inspecting colleges and training providers have frequently found myself in a conversation which seeks to establish what is being done to address the challenge.

At the same time, the discussion will often identify the poor impact of promotional activities and how these might be overcome.

Clearly there are societal attitudes to be overcome and I recall recently a television programme where children and their parents, separately, were asked to draw an image of people undertaking a range of jobs, from brain surgeon through to motor mechanic.

There was surprise (and some outrage) when the real job holders turned up proving that people, in general, hold a somewhat stereo typical view of what an engineer or technologist might look like.

There is no doubt, in my mind, that if young people were asked to draw a picture of an agricultural engineer, the resulting image may well reinforce the traditional image.

The same would probably go if they were asked to draw a picture of a hairdresser. The conclusion is that this is a complex challenge.

AGENDA ITEM

I can't think of any employer who would knowingly not buy in to the idea of promoting equality and diversity and may well latch on to the traditional matters of gender and race saying that they would be quite happy to employ anyone from these groups.

Why wouldn't they?

However, I feel that the matters of gender and race are a small part of the challenge facing our industry. I feel that the greatest challenge we face is the rural/urban divide, a point I made at a recent meeting and one which raised a few eyebrows.

Once I had described it, there was an acceptance that I had a point.

This comes down to the matter of "unconscious bias". Let me begin by defining what unconscious bias is: it refers to a bias that happens automatically, is outside our control and is triggered by our brain making quick judgments and assessments of people and situations, influenced by our background, cultural environment and personal experiences.

And then there is conscious bias, in other words, outright prejudice!

It is interesting that at a few meetings I attend, the challenge of unconscious bias is becoming a standard agenda item. And so it should, given that I have observed too many people (and at times myself) not taking on board a new concept on account of their past experience.

Perhaps we should all add this to our agendas as a constant reminder.

What are we doing to promote our industry to a more diverse audience?

NEW VIBRANCY

The question of the urban/rural divide became even more apparent in a conversation with a group of students following an Agricultural Engineering course about how many of them were from a "farming background".

It was the majority! This begs many questions.

What are we doing to promote our industry to a more diverse audience?

How can we change the perceptions of those people who look into our industry from the outside and perhaps have a preconceived view of who we are and what we do?

Are we, through our unconscious bias, unknowingly putting up barriers?

I fear the latter might be the case.

Is it time we started challenging the view by some employers that "we like to employ people from a farming background because they understand the industry, the working patterns and the need for long hours and flexibility".

By taking that view, surely we are closing the door and opportunities to those from a more diverse background who might bring new ideas and new vibrancy to our industry.

Perhaps those who complain the most about the recruitment challenge should hold up a mirror and ask if it is their unconscious bias which is the barrier?

TRAILBLAZER APPRENTICESHIPS

Workshop staged at Pershore College

Over 50 dealers and industry representatives attended a full day workshop outlining the new Trailblazer Apprenticeship standards at Pershore College on Tuesday 10 July 2018.

The meeting, chaired by Alastair Taylor, (CEO IAgrE) was organised by LE-TEC (Landbased Engineering Training and Education Committee Ltd), the umbrella organisation set up by the Agricultural Engineers Association (AEA), British Agricultural and Garden Machinery Association (BAGMA) and the Institution of Agricultural Engineers (IAgrE).

Industry consultant **David Kirschner** set the scene by outlining the obstacles that the industry had encountered since the publication of the Richard Report in 2012 which set out changes to the Apprenticeship framework. "Responsibility has passed through four different Government departments and five Ministers responsible for Apprenticeships," he said. "Since 2013 when we first got involved there have been numerous forced amendments and rewrites until we got final approval for industry specific standards this year – all at a cost of more than £60,000 to LE-TEC.

"There are now two Land-based Engineering approved Trailblazer apprenticeships, **Level 2 LBSE 'Service Engineer' Apprentice (18 – 24 months)** and **Level 3 LBSE 'Technician' Apprentice (36 – 48 months)**. All you need to know about each Trailblazer is outlined in two documents, **The Apprenticeship Standard** and **The Apprenticeship Assessment Plan**. All Standards and Assessment Plans have had to be approved and published by the Institute For Apprenticeships (IfA) otherwise no apprenticeship." All Trailblazer apprenticeship documents can be viewed on the IfA website.

Dealer View

Presenting a practical view on the challenges that face dealers, **Glen Nash**, Service Support Manager at the Turney Group said, "There's a lack of skilled people to recruit so we've gone the route of 'grow your own' not only in the industry but also in our way of doing things as well, to get the right culture and mindset. We try to take on apprentices most years but if there are no good candidates, we don't. The art is to screen candidates very carefully – and far too often we find that basic understanding of Maths and English is not as good as it should be.

"We often ask them to bring in photos and details of any engineering projects they have done at home or in their spare time, that often provides a good indication of their natural talents. But sometimes it's the simple things that hinder progress for instance we like to send apprentices away to college on 'block release courses' but we've had cases where they are 'home-birds' and miss Mum's cooking too much!

"We have no hesitation on sending apprentices on manufacturers courses, which are usually reserved for trained technicians, but if they've got potential then it's a great way of furthering their education".

Glen said that the pay rates they offered at Turney Group were rarely a block to recruitment. "We are in the Thames Valley, a region of high employment, but we've benchmarked our pay grades against other similar industries and we found that we compared very favourably, so money is rarely an issue.

"We also use the National Apprenticeship Service website to recruit, which has proved to be very useful from time to time."

Finally he said, "Accept apprentices will make mistakes, they will break things, but the important thing is to provide full support – and don't send them home unhappy if you can help it!"

The meeting also featured presentations from **Mark Eden**, Interim Director of

Workbased Learning for Warwickshire Colleges who provide a trainer provider view, an explanation of End Point Assessments from **Sally Green** of City & Guilds who was supported by **Steve Walker** from Ofqual on External Quality Assurance protocols.

DEERE BUYS SPRAYER COMPANY

Deere Company has signed a definitive agreement to acquire **PLA**, a privately-held manufacturer of sprayers, planters, and specialty products for agriculture.

PLA is based in Argentina, with manufacturing facilities in Las Rosas, Argentina, and Canoas, Brazil.

John May, President, Agricultural Solutions & Chief Information Officer at Deere said, "The PLA acquisition enhances John Deere's commitment to customers as we continue to provide innovative, cost-effective equipment, technology, and services to improve their productivity."

Founded in 1975, PLA was the first company to manufacture self-propelled sprayers in Latin America. The company has approximately 450 employees and currently markets products on four continents.

President's Musings

ENGINEERING 'THINK-TANK'

Draws inspiration from agricultural engineering

IAgrE President
PROFESSOR JANE RICKSON CEnv, FIAgrE

As this is my first ever "President's Musings", I would like to take this opportunity to thank everyone who has welcomed and supported me as I take on this exciting role!

It was wonderful to see so many people at the AGM back in May – including new and long-serving members (some marking their 60 years with the Institution!), and at least 11 Past Presidents (is that a record?).

I would like to thank Rob Merrall in particular for 'handing over the baton' – a real hard act to follow.

It was fitting that the Institution marked its 80th anniversary in the impressive surroundings of Wrest Park in Silsoe, Bedfordshire, home to the erstwhile National Institution of Agricultural Engineering (with my old *alma mater*, the National College of Agricultural Engineering, literally on the 'other side of the road').

For me, the day was reminiscent of my wedding – so many familiar, friendly faces and yet so little time to talk to everyone.

Seeing so many IAgrE members made me wonder - what is the collective noun for a room full of agricultural engineers?

As I start my 'term of office' (how grand!), these are significant times for agricultural engineering. Following Brexit, the whole future of food, farming and environment outside of the Common Agricultural Policy (CAP) has been the focus of the UK government's "Health and Harmony" consultation.

The outcomes of the public consultation will form the basis of the new Agriculture Bill expected by the end of 2018. As leading Professional Engineering Institution (PEI) in this area, the IAgrE has submitted a formal response, outlining how agricultural engineering helps achieve profitable food and farming, whilst also protecting the environment.

We can have influence on other national policies: for example, Defra have their 25 Year Environment Plan on "A Green Future: Our 25 Year Plan to Improve the Environment".

The Department for Business, Energy and Industrial Strategy (BEIS) Industrial and AgriTech Strategies demand high-tech, innovative solutions to "increase productivity and contribute to global food security and international development".

I would argue that all grades of IAgrE membership ultimately do this in our day jobs, whether we are carrying out essential maintenance on a combine harvester, designing a land drainage scheme, building rural infrastructure or writing up a scientific experiment for a learned journal (and of course, all the other things we do!).

The contributions agricultural engineers can make were brought home to me at a recent meeting of the Royal Academy of Engineering's newly formed 'Engineering Policy Centre'.

The Centre offers government departments focussed and specialist expertise on policy matters from engineering institutions like our own, in conjunction with the Engineering Council and Engineering UK.

It was fascinating working with other engineers from diverse sectors: mechanicals, civils, electricals, chemicals, even railway signalling engineers.

We all had to come up with a 'pitch' of how engineering can inform government policy. Interestingly (but not surprisingly), all but one of the six topics chosen drew on agricultural engineering, including the safety and ethics of machines and autonomous systems; better health care (including how to deliver nutritious and safe food); developing vital skills for the future; and (my favourite!) devising a national food policy.

Agricultural engineers have unique skills and know-how to help the UK produce cheaper, safer, healthier food - and that's of relevance to everyone in society – we all have to eat.

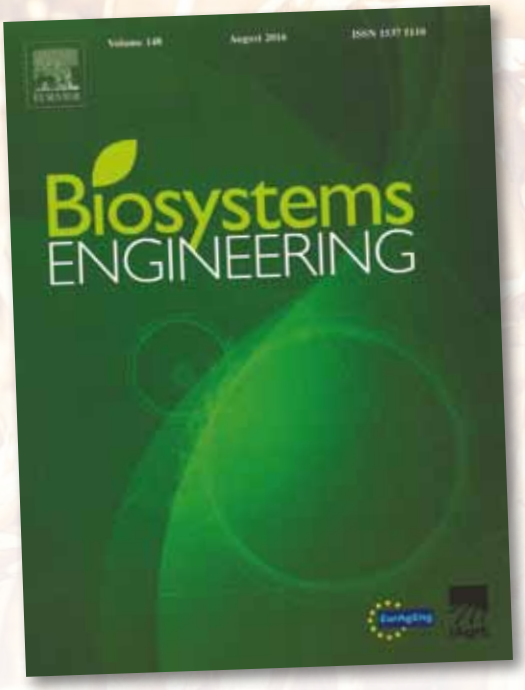
Our membership represents all stages of that supply chain from 'field to fork': demonstrated or example by the design of seed-bed cultivation equipment; robotic crop harvesting; food manufacturing and processing; extending product shelf life in our local supermarket, etc. etc.. Being part of the EPC gives us an opportunity to engage with (and learn from?) other engineering sectors and promote what agricultural engineering has to offer in addressing the challenges ahead.

Finally, I look forward to seeing you at the Annual Conference on Knowledge Exchange at the Royal Academy of Engineering in November.

Book your ticket now - and do let me know your ideas for that collective noun.

Biosystems Engineering

Biosystems Engineering, owned by IAgrE, and the Official Scientific Journal of EurAgEng, is published monthly with occasional special issues.



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www.iagre.org/biosystemsinformation

The Managing Editor of Biosystems Engineering, Dr Steve Parkin, has kindly summarised a selection of papers published during the last three issues which he thinks will be of interest to IAgrE members.

Biosystems Engineering
Volume 169, May 2018, Pages 1-10
Reducing field work time using fleet routing optimisation
Hasan Seyyedhasani, Joseph S.Dvorak
University of Kentucky, Lexington, KY, USA

Agricultural producers seek to complete field work as quickly as possible. This is achievable through the simultaneous use of multiple vehicles for an operation. However, path allocation and scheduling then must be considered. Transforming the field work problem into a Vehicle Routing Problem (VRP) and using optimisation procedures designed for this problem provides a method of allocating paths. In this work, the accuracy of a VRP representation of field work is confirmed and the ability to reduce field work times is verified. Experiments were conducted using three tractors during a rotary mowing operation. First, the traditional routes used by human drivers were recorded. Then, a VRP representation of this operation was created, and new routes generated by a Tabu Search optimisation procedure. Using these routes, the time to complete the field work was reduced by 17.3% and the total operating time for all tractors was reduced by 11.5%. These reductions illustrated the ability of the route optimisation procedure to improve effective field efficiency.

Biosystems Engineering
Volume 170, June 2018, Pages 24-30
Drying rate control in microwave assisted processing of sliced apples
Gennaro Cuccurullo, Laura Giordano, Antonio Metallo and Luciano Cinquanta
University of Salerno, Italy
University of Palermo, Italy

The most enhanced microwave systems for the preparation of quality-dehydrated fruits continuously adjust the power level in order to maintain the product temperature above a target value. Typical drying curves exhibit high drying rates in the middle stage. This can often lead to quality damage or undesirable changes on food colour and texture. In response to these issues, a microwave system is proposed that can realise drying processes keeping drying rates constant. This approach required a continuous temperature adjustment of the apple slices under test, whose temperature was detected by a computer-aided infrared thermography system. Since temperature corrections were required only during the middle stage of the process, the overall drying time was only slightly affected by the proposed control strategy. Nevertheless, compared to microwave drying with different constant temperatures (60, 70 and 80 °C), the resultant benefits of operating at constant drying rates included an improvement of texture and rehydration properties. No differences in colour of sliced apples were observed.

Biosystems Engineering
Volume 171, July 2018,
Pages 101-119
Automatic carbon dioxide enrichment strategies in the greenhouse: A review
Yongwei Li, Ying Ding, Daoliang Li, Zheng Miao, China Agricultural University, Beijing, China

Greenhouses constitute a proven solution for coping with environmental degradation and for increasing both the quantity and quality of agricultural products. Appropriate CO_2 control not only improves crop yield and quality but also reduces the carbon footprint of greenhouses. However, CO_2 enrichment control in greenhouses is a dynamic, interactive and time-delayed process. In practice, optimal CO_2 concentrations in the greenhouse are difficult to maintain because CO_2 is confounded with temperature, humidity, light intensity, etc.; therefore, ambient CO_2 concentrations in greenhouses are often suboptimal or excessive. Current theoretical and applied studies of CO_2 enrichment in greenhouses are reviewed and the advantages and limitations of various methods discussed. The major points are: 1) the five sources of CO_2 enrichment in greenhouses; 2) the monitoring and data processing of CO_2 concentrations; and 3) the various methods for controlling automatic CO_2 enrichment. New challenges and perspectives are discussed and future studies and methods are suggested for a greenhouse CO_2 enrichment system. A new symbiotic greenhouse system requiring sensible CO_2 balance is presented.

COVER FEATURE

THE DISAPPEARING TRACTOR?

Manufacturers continue to build ever more powerful, bigger and heavier tractors, but have they reached optimum size? Will the next few years result in the natural advancement from horses, to tractors, to commercially viable robotic, smaller, smarter technology? In short, are we seeing the beginning of the end for the tractor – as we know it?
CHRIS BIDDLE REPORTS

The Institution of Agricultural Engineers (IAgrE) was formed at a pivotal crossroads for farm mechanisation in the UK.

In 1938, there were 550,000 horses at work on British farms – and just 55,000 tractors according to Claude Culpin's book ***Farm Machinery***. By the end of the war, the farming scene had been transformed, both in numbers and useage. By 1951, over 300,000 tractors were in use, compared with 250,000 horses which were to almost completely be replaced by tractors within a decade or so.

So, it is perhaps more than a happy co-incidence that the creation of IAgrE in 1938 coincided with Harry Ferguson entering into an agreement with Henry Ford to build the Ford 9N tractor. Ferguson was the inventive genius having incorporated a three-point linkage and power take-off system into a tractor, whilst Ford had the mass production facilities to ensure its commercial viability.

The tractor of today was born.

However, technological advancements during the past two decades, particularly in robotics, data rich sensing and monitoring systems have brought us to question whether, the tractor as we know it, has reached its peak and whether it is likely to be the main power source for farming applications in the future?

The **Automated Innovation Conference** held at Harper Adams University in July provided a range of views and examples that questioned the viability and suitability of modern tractors as they have developed into ever more powerful and heavier power units. "They are nothing more than a heavy, soil damaging and destructive drawbar" said one speaker. Another warned about trying to adapt existing tractor design.

"We need to start from scratch, the future lies in smaller, lighter autonomous farm vehicles suitable for new ways of farming" said another.

All agreed that the technology now existed to move to a third age of farm mechanisation, and it was a question of how and when, rather than if.

EVOLUTION

Of course, the tractor in its various guises had been around since the early 1800s thanks to the skills of a band of English engineers including Cornishman Richard Trevithick, William Tuxford, John Fowler and Thomas Aveling who developed different applications for steam-powered tractors.

It wasn't until 1892 that US inventor John Froelich built the first gasoline/petrol powered tractor, made at the Waterloo Engine factory in Iowa (later purchased by John Deere). Unfortunately, Froelich's vision was ahead of its time, only four tractors were produced, two sold (and they were returned by dissatisfied customers).

Meanwhile in 1896, Lincolnshire engineers Richard Hornsby & Sons manufactured the first oil-engined tractor fitted with a 20hp engine which became the first recorded sale of a tractor in the UK and won the Royal Agricultural Silver Medal in 1897.

This was followed in 1901 by British inventor Dan Albone with his Ivel Agricultural Motor. The 'tractor' had one front wheel and two large rear wheels, was water-cooled and had one forward and one reverse gear. With sales of over 500 (both in the UK and overseas), the Ivel became the first commercially successful tractor,

ABOVE: Harry Ferguson (l) next to Henry Ford with the Ford N Tractor

winning the Royal Agricultural Show medals in 1903 and 1904.

The real shift from horses to tractors came in 1917, when Henry Ford introduced the Fordson, the first mass produced tractor made in factories in the US, England, Ireland and Russia which commanded almost 80% of the market by 1923. Just as Ford had brought cheap motoring to the masses with the Model T, so the Fordson F did the same for farm tractors.

In many ways, the Fordson F was a crude, simple machine, built down to a price. The launch cost to farmers in the US was $795 but later slashed to an extraordinary $230. Thus Ford persuaded a whole generation of farmers to buy their first tractor – and over half a million were sold. Ironically, Henry Ford decided to leave the American tractor market in 1927 to clear production space for a new car, but production of the Fordson continued in the UK and Ireland.

Other manufacturers started to emerge, as the demand for greater sophistication grew.

Harry Ferguson started the other way round from other engineers. Using a combination of springs and levers, coupled with clever geometry, he came up with the idea of hitching implements to the tractor easily with his three-point linkage thus providing draft control and using the implement's drag to provide downforce to the tractor's rear wheels – and proceeded to build a tractor around his new ideas.

It was a huge leap forward in tractor design and formed the basic design around which all tractors from the 1930s to today have been developed.

The war years slowed technical advances, but during the 1950s and 1960's the restraints were off. First came the adoption of diesel engines, then multi-speed transmissions, four-wheel drive – and of course burgeoning power.

John Deere were the first with a diesel wheeled tractor, the Model R in 1947, others followed suit and by the early 1970s, petrol engines had virtually disappeared. Manufacturers fell over themselves to outdo the competition with new features and more powerful tractors. Transmissions were evolving with the introduction of multi-ratio gearboxes, every manufacturer coming up with an eye-catching name such as 'Power Director', 'Ampli-Torc', 'Torque Amplifier', 'Case-O-Matic' – and the splendid Ford 'Select-O-Speed'.

PEAK POWER

During the 1960's, speed and power was the thing. For airliners, cars, motor-cycles, trucks - and tractors. The race to the top had begun. Recently, in the same Nebraska Test Lab where the early Waterloo Boy tractor had been rated at 25hp, testers rated a Challenger tractor at 635hp. AGCO's Product Manager Jason Hoult says "700hp is possibly the peak, otherwise you are looking at a locomotive on wheels".

Tier 4 emissions standards are adding a significant cost to the price of tractors. The easiest way to add value to offset these additional costs to the consumer is to add more horsepower to the tractor.

"Farmers know the costs are going up because of emissions, and that is what's driving tractors to go for higher horsepower in the same chassis" says Hoult.

"In addition, since horsepower is a function of mass, a larger engine would require a larger tractor. We've reached a point where the efficiency for size is starting to fall off," he adds. "To put power to the ground you need 100 to 110 lbs per hp. Tractors need to be so much bigger physically and implements need to be so much bigger to use the power on the top end – and they still need to fit on our roads and bridges".

But big tractors are still an attraction for buyers – and the public. "We called it Tractor Porn" says Jane King, a former Editor of Farmers Weekly "when we put a big, new shiny tractor on the front of the magazine, circulation would go up by about 3000 that week".

In the ten years from 2008 to 2017, statistics published by the Agricultural Engineers Association (AEA) show a rise in the average horsepower for tractors sold in the UK (over 50hp) from 138hp to 162hp.

There is a growing view that we are reaching (or even have reached) the upper limit for operating efficiency of the tractor.

Autonomous vehicles are still in their commercial infancy. But the industry is starting to think outside the box, employing disruptive technology and discovering new ways to manage food production in the future.

Building bigger and heavier tractors is unlikely to be the way forward.

The Hands Free Hectare initiative in preparing a field, then growing and harvesting a crop may have been small scale, but it proved an important logistical point that autonomous farming can be feasible proposition.

The trick will be to harness the talents of those working in agri-tech and to move beyond demonstration plots to commercial viability. That will need smart thinking and above all, collaboration across the industry.

There are plenty of those waiting to take up the mantle – and in the following pages we report on speakers at the Harper Adams Innovation Conference who intend to turn concept into practical reality in the years ahead.

HARPER ADAMS HOSTS FIRST AUTOMATED INNOVATION CONFERENCE

The National Centre for Precision Farming (NCPF) hosted its first Agricultural Innovation Conference and Exhibition at Harper Adams University on Tuesday 3 July 2018.

Chaired by **Parmjit Chima**, Head of Engineering at Harper Adams, the event was sponsored by AHDB and supported by Agri-Tech West and opened with a keynote speech by **Caroline Drummond MBE**, Chief Executive of LEAF.

"In the mid-2000s we were talking about the social media age" she said "Today, we are in the collaborative economy age – and its great to see agriculture at the forefront of the upcoming autonomous age".

The conference also featured presentations from **Kit Franklin** and the Hands-Free Hectare team, **Clive Blacker** of Precision Decisions, Canadian farmer **Owen Kinch**, **Dan Halliday**, Global Product Manager for Precision Land Management at New Holland, **P Nageshawar Rao**, Senior Chief Engineer, TAFE tractors, **Sam Watson Jones** of the Small Robot Company and **Jane King** of AHDB.

"47% of jobs today, won't be here in 25 years time"
Caroline Drummond

"In 1993 we were pulling a Massey 4 metre drill with a 97hp tractor, today we are pulling a 4 metre Mzuri drill with a 263hp tractor"
Clive Blacker

"The future will involve small, versatile, robotic vehicles"
Kit Franklin

"The customer would pay more if we could offer full autonomy today"
Dan Halliday

"Tractors have become expensive and powerful drawbars"
Owen Kinch

"We will not achieve anything by automating existing tractors"
Sam Watson Jones

"We now really need to wake up the industry"
Jane King

AUTOMATED INNOVATION CONFERENCE: THE SPEAKERS

OWEN KINCH
JOINING THE DOTS
One power platform, multi-implements

As the reality of autonomous farm equipment draws ever closer, the shape of farm equipment is changing radically – and a practical example of that is being seen in broad acres of Canada.
Saskatchewan farmer and consultant to the SeedMaster drill company, Owen Kinch, outlined the concepts behind the prototypes trialled in his fields this summer which do away with all previous concepts of the traditional tractor.
Developed by DOT Technology Corp, the DOT power platforms are designed to work in the field autonomously with a number of implements ranging from a 30-foot air seeder, a 60-foot sprayer with 1,000-gallon tank, a 41-foot land roller for pulse crop production, and a 500-bushel grain cart.
The autonomous DOT Power Platform is the result of a three year quest to make farm equipment more efficient in the context of the labour shortage in farming, says the system's creator, Norbert Beaujot who also owns the SeedMaster drill company. "In the past, ag manufacturers have addressed the farm labour issue by making bigger equipment to cover more acres in a day" he says "but bigger isn't always better"
"Besides the inefficiencies of 80 or 100 foot drills, there's just too much cost for the farmer, and if a big tractor goes down for any reason, his whole livelihood is affected as a loss of a few hours or days can be devastating."
At the time, Beaujot was working on an autonomous seeder "But when I came up with the thought of the U-shaped platform, and how it could easily be adapted to almost any piece of equipment, that's when I got excited and filed for patents," he says.
Beaujot and his team spent two or three years gathering information, visiting electronic trade shows, drawing up ideas, and making contacts in the autonomous vehicle industry.

EASY LINKAGE

DOT's power platform is relatively simple as it consists of a heavy-duty U-frame, a 175 horsepower, Tier 4 Cummins diesel engine and hydraulic pump, 4 steerable wheels and hydraulic motors for each.
The machines are equipped with an 85-gallon fuel tank and can operate up to 12 mph. The transport width is 12ft 4", length is 20ft.
To operate the DOT, the farmer uses a remote control handset to guide the machine to the DOT-ready implement. The implement fits within the "U" of the DOT's frame and is lifted by four heavy-duty linkages where it is pinned in place for use.
Once in the field, the DOT uses GPS positioning to follow maps programmed into its processor and is controlled by a tablet human-to-machine interface. The tablet display gives the operator real-time engine operating conditions and access through an ISOBUS connection to communicate with the implement.
A number of fail safe features are built into the DOT to stop it if it veers from its predetermined path, or if it encounters an obstacle along the way.
Owen Kinch said "Earlier this year we launched a deposit program in which interested growers can put down $1,000 as a deposit for a DOT built between 2019 and 2022. We see our market area as Canada and the U.S., Australia and Europe, so we may have to shift production around a bit based on where the orders originate".
The power platforms will be built by DOT's sister company SeedMaster Manufacturing Inc., which has the capacity to produce 300-500 units per year but will take a couple of years to ramp up to that level of demand.
Kinch said the machines are designed to cover the same land mass in a day as a good size traditional combine, regardless of the implement being used, to enable them to fit into existing farming work schedules.
The DOT improves productivity through the use of one power platform for many implements, efficient use of power through effective weight transference of the power platform (12,500 pounds dry weight) and the implement, and significantly reduced maintenance and labour requirements.
So where will the DOT go from here? Will it revolutionise field work as we know it?
"Part of that will depend on how other manufacturers respond to the DOT" said Owen Kinch "We are already encouraging other manufacturers to build 'DOT-ready' implements".
Price will also be a factor in adoption of the DOT concept, he said, but the system will be competitively priced relative to traditional tractor/attachment combinations, "From a cost perspective, it's also worth noting the cost of many of the components on the DOT have fallen dramatically, and continue to fall, as vehicle manufacturers and suppliers have invested in LIDAR and other sensors for autonomous cars and trucks".
With the initial models built and operating on trial, the DOT project is still in its infancy – and the next chapter has yet to be written.

KIT FRANKLIN:
HANDS FREE HECTARE

CURING THE 'WOBBLY' TRACTOR

From Post-It note to BBC Award

"We were successful in completing our main objective in the first year proving that a field could be farmed without any humans working the land directly and using only off-the shelf technology and open-source software" said Kit Franklin.
The world-first project run by Harper Adams University and Precisions Decisions to drill, tend and harvest a crop without operators on the machine and agronomists in the field won the team world-wide publicity – and at the end of the cycle a batch of Hands Free Hectare gin distilled from the harvested grain.
"Although everything worked pretty well to plan, pictures taken from above by a drone looked as if we had a pretty wobbly tractor at work!"
The project, run by Kit, Martin Abell, Jonathan Gill and Clive Blacker of Precision Decisions, returns for a second season thanks to £200,000 worth of support from Innovate UK , along with new partner AHDB and industry supporters, the Hands Free Hectare team are hoping to improve the accuracy of their machinery, and therefore improve the yield at harvest next year.

DRILLING

Drilling of its second crop; a hectare of winter wheat, took place on 18 and 19 November, followed by spraying in June.
"We had to abandon our first attempt to drill this season's crop because it was raining quite heavily and the tractor was starting to slip around and lose its straight lines" said Kit.
"The reason we're doing the Hands Free Hectare again is to prove we can go straighter. After ten days of dreary weather, we managed to come back out and complete the task".
"When we drilled our spring barley earlier this year, the tractor was a bit wavy and so were the drill lines. We've had six months to develop the system and we've seen improvements which will improve field coverage and ultimately yield. The tractor was still a bit wayward when turning back into the field, but once it's on the line it was really straight with pass to pass cover greatly improved"
We're trying to push for a more competitive yield compared to what you see on the AHDB recommended lists and all other trials data available."
"It was brilliant to be part of the team that achieved this world first and to help lay down a marker in this sector. We've recently started seeing many commercial organisations coming out with their own autonomous agricultural solutions, showing that there're working on this. I think we could start seeing autonomous tractors and robots on farms any day."
"The media coverage that we got from the first round of the project was phenomenal – it truly went global and new items are still coming in. We're pleased that we've had such an impact and started to get people really talking about automation in agriculture and how it's already possible".
The icing on the cake came in July when the Hands Free Hectare project won the Future Food Award at the BBC's 2018 Food and Farming Awards ceremony held in Bristol.
The project was demonstrated for the first time away from the university campus earlier that day at Cereals 2018, near Cambridge. The combine's first demo, held in the morning, didn't fully go to plan but the team worked hard to ensure it would be ready for the afternoon slot; which proved to be a success and received a fantastic reaction from the audience.
Kit Franklin said: "It was a race to get from Cambridge to Bristol in time for the awards ceremony. We left Cereals on a high after our combine performed so well, but then the nerves started to kick-in while we were waiting for the winner of our category to be announced.
"It's an amazing feeling to have won this award. Who would have thought mine and Jonathan Gill's idea, written originally on a post-it note, would get this far?"

5G

Key to the advancement of autonomous farming applications is the availability of super-fast broadband. Kit Franklin said that the Hands Free Hectare project will soon be boosted by the availability of one of the first 5G networks in the UK.
5G RuralFirst, led by Cisco and lead partner University of Strathclyde, is to deliver testbeds and trials to exploit 5G benefits for rural communities and industries such as agriculture.
Based primarily on the Orkney Islands, and in the farmlands of Shropshire and Somerset, the 5G RuralFirst project will integrate spectrum sharing strategies for 5G; bringing connectivity to rural communities, enabling smart farming in partnership with Agri-Epi Centre (including drones, autonomous farm vehicles and remote veterinary inspections); innovative methods of delivering broadcast radio over 5G working with the BBC, alongside the delivery of 5G connectivity for IoT in utility and other industries in rural areas.

Dan Halliday
VINEYARD PROJECT
Autonomous New Holland tractor in Californian vineyard

Skilled labour shortages are going to drive the transition to autonomous farming advances said Dan Halliday, Global Product Manager for Precision Land Management at New Holland Agriculture, based in Chicago.

Halliday is no stranger to the UK, the son of a Leicestershire farmer, he gained a degree in Agriculture at the University of Reading, worked for a New Holland dealer in southern England before joining New Holland. He is also a former National Chairman of the Young Farmers Club.

"Key farm manufacturers are all working in some way on autonomy," he said "Niche companies and after-market suppliers also are developing autonomous solutions, which adds pressure across the industry to keep moving ahead"

In 2016, both New Holland and Case IH introduced autonomous tractor prototypes, which are still being tested in the field.

"We've done a lot of work since then," Halliday says. "We are working on sensor technology to make the driverless operation viable. And we launched smart auto-turn features last year."

But there's still work to be done, he adds. "There are applications that will need more work before we can fully automate them. If you want to till a field, it's relatively easy to automate. However, if you're combining, there's a lot more going on."

For many years, the high cost of components needed for autonomous vehicles was partially responsible for ag manufacturers not bringing the vehicles to market. But that is changing.

Uber, Google and Tesla have made big investments in technology for their self-driving cars. This development has substantially lowered the cost of some components that are also used in automated farm equipment.

Autonomous and semi-autonomous equipment also may do the job better. "Autonomy takes out potential human error and gives the user a choice to operate overnight or for 24 hours," says Halliday. "Clearly growers can benefit from increased efficiency on their farms utilising these technologies."

VINYARD

New Holland is partnering with E&J Gallo Winery, the world's largest family-owned winery, in a pilot project testing its NHDrive autonomous technology on the T4.110F vineyard tractors.

The programme at E&J Gallo's California vineyard is gathering agronomic and operator feedback on autonomous technology in everyday vineyard activities as part of its Autonomous Vehicle Programme's bid to find the applications that can benefit from this technology.

This pilot is focused on vineyard maintenance and crop production tasks and aims to develop these activities for autonomous operation.

The data generated during the pilot will provide real-world detail on possible automated and autonomous applications.

Dan Halliday says the autonomous tractor could be as "soon as three years" away, but indicates there are significant hurdles to jump.

These include "more investment and resources pumped into the perception and sensing systems", the safety issues inherent in an unmanned tractor, and, of course, the prohibitive cost of the technology.

Sam Watson Jones

TOM, DICK AND HARRY GET TO WORK

'Robots in full use on farms in 10 to 15 years'

"Farmers will be put out of business by the continued use of the tractor as we know it". That was the forceful view expressed to the conference by Sam Watson Jones,

"Over the last few years, farming costs have been inflating by between 10% and 12% a year, especially in machinery" he said. "Farmers are no longer able to absorb these rises, and given that 85pc of UK farms are not viable without subsidy, the model needed to change."

Tractors and heavy machinery will be replaced with smaller, autonomous gadgets for planting and feeding crops – and these robot helpers will even blast weeds with lasers. This is the future envisioned by former Accenture consultant and fourth-generation farmer Sam Watson-Jones, who launched the Small Robot Company a year ago with co-founder Ben Scott-Robinson to help farmers survive the combined pressures of rising costs, volatile commodity prices, and subsidy cuts following Brexit.

The technology behind Small Robot Company's technology is based on 15 years of research by Professor Simon Blackmore expert in precision farming at Harper Adams University.

To date, Watson-Jones has invested £100,000 of family money into his start-up, with plans to invest a further £100,000. The company has also received funding and support from Innovate UK, the Institution of Engineering and Technology (IET) and is currently crowdfunding £50,000 on Indiegogo in a bid to raise awareness with consumers and supermarkets.

SAVINGS

The Small Robot Company has developed three robots – Tom, Dick, and Harry, as well as an artificial intelligence platform called Wilma – to help farmers dramatically boost yields, reduce the use of chemicals and use big data to drive efficiency. These smart robots will enable farmers to lift revenues by up to 40%, and reduce costs by up to 60%, he claimed.

"Tom is our monitoring robot," explained Watson-Jones. "It takes a picture of each individual plant in the field, creates a map of the farm, and measures the nutrient balance and texture of the soil every square metre." This data is then passed to Dick, the robot in charge of microspraying and non-chemical weeding. It only applies micro-doses of chemicals or fertilisers to the plants that require treatment, minimising the use of toxic chemicals by up to 95pc. It uses a precision laser to kill weeds.

"Farming is one of the most polluting industries, and nitrogen fertiliser is one of the worst culprits. We can't solve it single-handedly, but the robots will generate a dramatic reduction in waste chemicals."

Harry is a planting robot, which injects seeds into the soil at the right spacing and depth for the plant to be successful. It does away with the need for ploughing, which churns the soil, damaging earthworms and disturbing the soil's natural ecosystem.

Small Robot Company is offering customers access to its robots under a "farming-as-a-service" model, which means that farmers lease the equipment and pay a fixed fee of £600 per hectare each year. "On my farm, I have £1m worth of equipment in the shed and most of it is only used for three weeks of the year. We're solving that problem for farmers."

According to Watson-Jones, when modelled on his 1,200-acre arable farm in Shropshire, the cost of his technology represents a saving of £50,000 per year on traditional farming costs. This data has been validated by Andersons, the farming consultancy group.

The Small Robot Company's robots are currently being trialled for wheat production, although they will eventually be capable of farming any arable crop. Watson-Jones forecasts that his robots will be farming 5% of the UK wheat market in five years' time, generating £90m in annual revenues for his company.

"I'm very worried about the future of British farming," said Watson-Jones. "We are producing commodity products in one of the most expensive countries in the world in which to do so, and doing it at a tiny scale. Whether it's Small Robot Company or another company providing the robots, we need to move to this new model if the industry is to stand a chance.

"Tractors were massive drivers of productivity during my grandfather's time, because of the benefits generated by reduced labour and increased yields," said Watson Jones. "But now the tractor is putting farms out of business. Everyone will be using robots like this in 10 to 15 years.".

Clive Blacker
ROBOTIC SOLUTIONS
Horsepower 'a guilty pleasure'

"The real challenge we have as an industry, is to encourage and assist farmers to use new technology" said Clive Blacker of Precision Decisions, a partner in the Hands Free Hectare initiative.

"I reckon in many ways we have gone backwards in many aspects of farming over recent years. We are worse at precision farming than we were 20 years ago, we use less data, tractors are getting bigger and heavier (an 18% gain in average horsepower during the past 8 years), and whereas in 1993 we were pulling a Massey 4m drill with a 97hp tractor, today we are pulling a 4m Mzuri drill with a 263hp tractor".

"And we call that progress?"

Mr Blacker also said that farmers and operators were getting too remote from the soil. "Look at the height of the seat on the bigger, high-horsepower tractors compared with when farmers could be closer to soil. The further from the soil you are, the more your head is in the clouds!"

He said that crops grown, such as oil seed rape were often dictated by the machinery inventory of the farmer.

"But if robotics are to be the answer, then we have to make a convincing economic case for a whole new approach. There is little doubt that robots can offer much more precise targeting for the control of plants. As sprayer booms get wider and wider then high resolution mapping and sophisticated sensors can provide variable application rates across the width of the boom"

"But to provide robotic agricultural solutions, will need better skills and training in order to support and use new technology. Whilst some areas of food production will be affected by labour shortages, that is unlikely to be the case in broad acre agriculture"

"As an industry, we need to understand the economics of robotics – and there are only limited business cases. Growing practices need to be reviewed, as does our understanding of previously accepted agronomic principles".

"Lastly, agricultural engineering needs investment to unlock the potential of new sensors and new demands that the industry needs for high resolution application and mapping technology"

SUMMARY *"Tractors will never replace horses – unless the tractor can raise a young tractor every other year!"*

Canadian farmer, Owen Kinch quoted this wonderful phrase from the early 1900s in the US - which is on a par with Ken Olson's prediction in 1977. The chairman of Digital Equipment Corp said, ***"There is no reason anyone would want a computer in their home".***

History is littered with predictions and forecasts that have subsequently proved to be way off beam.

For this issue of ***Landwards*** to run a feature questioning the future of our prime mover might be regarded as provocative.

But in the closing Q & A session of the Agricultural Innovation Conference at Harpers Adams, you had to feel some sympathy for Dan Halliday, Head of Global Planning for New Holland based in Chicago.

Dan, a former National Chairman of the Young Farmers Club in the UK, is immersed in the tractor business, today and in the future. Yet, on either side of him, Sam Watson Jones from start-up Small Robot Company was saying *"The UK is being put out of business by the use of the tractor"*, on the other Owen Kinch wanting to replace the tractor with his robotic toolbar with mounted seed drills, sprayers etc. *"I want do without service calls by dealers"*

Of course, tractors won't disappear. But the trend for bigger and more powerful models? Perhaps we have now reached the peak and need to rethink.

I had the distinct impression that this conference signalled a tipping point when all the talk, all the theory, all the prototypes were gradually being put to one side and real advancements in farm automation were now ready to be put to practical use.

All the science and technology is largely in place, and the question is really about the pace of adoption of new technology. ("You can take a horse to water . . .").

New technology can signal new farming practices. Smaller, lighter machines providing versatility, greater control – and less damage to soil.

A transition is underway. How long will it take? Ask a dozen farm machinery gurus – and you'll likely get 12 different answers.

But we are definitely on the cusp of a brave new world during which time there will be successes and failures.

Will we look back in 2038 when IAgrE reaches its century and look at the 'antiquated' farm machinery in use today? For something of an answer, look back the other way 20 years.

The internet was in its infancy, mobile phones were as big as a brick, broadband had only just been invented and we were setting our VHS machines to record Coronation Street. (And wait another 10 years for the iPhone).

So predictions are out, but if you have some then I love to hear them!

Chris Biddle

1938 2018 IAgrE

PERSPECTIVES

Selected extracts from latest UK's professional engineering journals.

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Electric drivetrain concepts for tractors smaller than 100hp

Replacing the conventional ICE with an electric drivetrain without affecting vehicle structure is the most applied concept in commercial battery electric vehicle technology. But as well as these practical implementations, other solutions enabling added value, such as environmental protection, must be considered.

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Fig 1

Step 1 - Mild Hybrid **Step 2 - Full Hybrid**

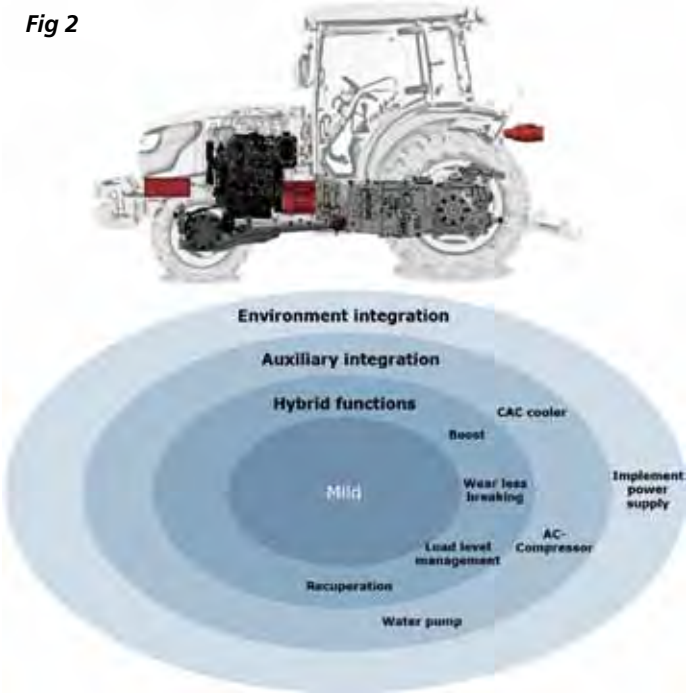
Battery electric vehicles are becoming more and more important in commercial vehicle technology. Replacing the conventional internal combustion engine with an electric drivetrain without affecting the vehicle structure is the most applied concept. So it is realised, for example in wheel loaders, forklifts and tractors. In addition to these practical implementation variants, other solutions must be considered which can also represent added value, for example in terms of environmental protection depending on the intended use of the vehicle.

While regular emission violations are being proclaimed in various major European cities, scenarios are increasingly being considered as to how the burden of combustion engines can be reduced. This is especially concentrated in conurbations and affects diesel engines. The environmental badge introduced in Germany in 2008 already serves this purpose, while there are still discussions going on about total bans for diesel driven vehicles in defined sub-areas.

Nevertheless, there is an enormous potential for electrification, especially in the municipal power classes, which can already be covered with todays technology. It is exactly those performance classes, in which a vehicle traction power of 100hp is typical, that are also found in the cultivation of special crops such as vineyards and orchards.

Although this is considered less due to the rural situation with the particulate matter in metropolitan areas, here the cultivation of products that are subject to the organic label, the sustainability of the entire process chain can be underpinned by cultivation, nurture or harvest by lower emissions or even emission-free. The path to full electrification can be broken down into three main stages, as shown in ***Figure 1***.

Fig 2



The three steps from mild hybridization through full hybridization to the battery electric vehicle are based on each other in terms of development effort and system costs. With each additional step, more functions can be implemented, some of which are already known today in the automotive industry. The optimization in emissions also comes into effect with each further expansion stage.

INTEGRATION OF MILD HYBRID SYSTEM

The basic idea of the mild hybrids is the downsizing of the diesel powered internal combustion engine. While tractors in higher power classes are only allowed to be sold with the European emission level 4 since 2014, vehicles classified in vehicle category T2 are only affected by emission level 3B. This category includes most municipal and special crop tractors.

With the beginning of the year 2022 the levels will be updated, so that with the introduction of the emission level 5 stricter limit values also apply in this level. The key point is that T2-interim vehicles with a diesel output of less than 56kW (76hp) are to be given special consideration, as no distinction is made between hydrocarbons and nitrogen oxides for this performance range.

It is likely that only an oxidation catalytic converter and a diesel particulate filter will be used to maintain the total particle count. An additional SCR is not required. This point can be addressed for vehicles that have an output power of more than 56kW, by downsizing the diesel engine below the limit of 56kW and providing the remaining power of up to 20kW via an electric motor in parallel with the diesel engine.

It can be assumed that the reduction of the diesel engine will provide enough space to accommodate the electric motor, the power electronics and the required battery also under the hood so that the rest of the structure of the vehicle, as shown schematically in ***Figure 2***,

Step 3.1 - Full Electric

Step 3.2 - Full Electric

remains unchanged.

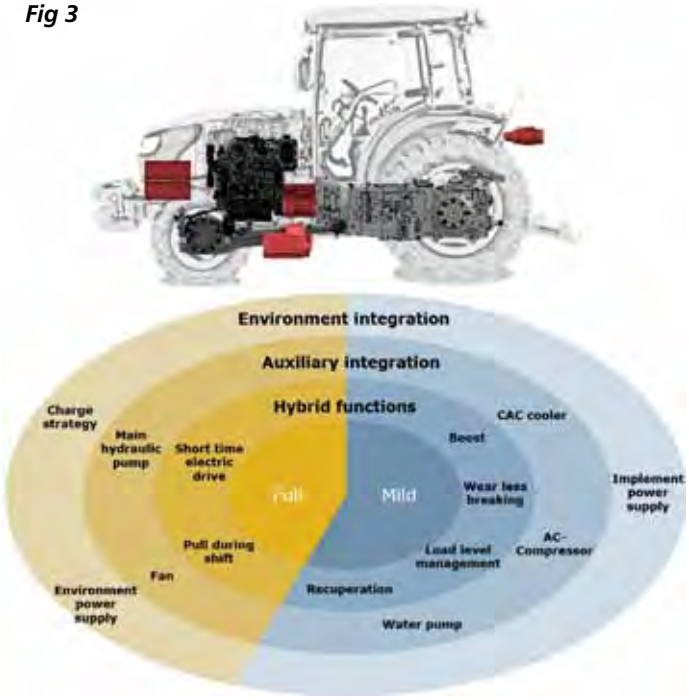
The battery can be realised relatively small in this configuration with a capacity of about 6kWh. The main task of the energy storage is to gain energy in case of braking in the sense of recuperation or in lower load points of the diesel engine. For those operating points in which a traction power of more than 56kW is needed, a battery-powered boost can be superimposed on the system via the electric motor, so that no functional disadvantages will arise for the user in comparison to the conventional tractor.

The vehicles of the questioned performance class are particularly suitable for such a system, since working under continuous full load is more of an exception in this segment. Beyond the basic function, the hybrid system can also be used to protect the vehicle brakes by slowing down the vehicle over the electrical power path or at least to keep it at a constant speed for longer downhill drives, as they often occur both in the communal area and for example in viticulture.

Additionally, it is conceivable to build up on this system and complete the electrical power path in excess of the traction driveline, so that the typical auxiliary consumers of the diesel engine are electrically controlled independently instead of being propelled by the belt drive. Without overloading the electrical system, the cooling water pump or the charge air cooler can be controlled as needed.

The overall efficiency of the vehicle is optimized by not controlling the auxiliary drives proportional to the engine speed but depending on the engine load. In addition, an electrification of the air conditioning system is conceivable, so that the components of the air conditioner can be fully integrated into the cabin. Going beyond the system limits of the vehicle, additional electrical power can be supplied to implements for precision drives as demonstrated by Fendt in the run-up to Agritechnica 2017.

Fig 3



In this context, the low proportion of electrical power has an effect, since such a system can be realised with an electrical rated power of up to 20kW in the low-voltage range of for example at 48V. An additional voltage conversion for the operation of a 48V powered implement is not necessary.

EXTENSION TO FULL HYBRID-SYSTEM

Depending on the available installation space, the mild-hybrid system can be supplemented into a full-hybrid system by integrating further components. It is assumed that in addition to the battery capacity that is needed to cover the power peaks, further battery modules can be integrated into the vehicle structure.

A system structure like this allows additional functions, such as a short-term fully electric operation. While this is used in the automotive industry primarily in urban transport, where it is referred to as 'gliding', the importance of such an application can be found especially in todays fully electric loaders

For indoor applications – such as feeding or storage work – the diesel engine can be deactivated and the vehicle is switched to the emission-free drive. This function can be supplemented by an additional electric motor at the same power level, which can be designed as a fully electric front-axle drivetrain based on the limited space available as shown in ***Figure 3***.

This arrangement of the second electric drive unit allows two further functions, in addition to battery only operation. The function of the shift assistance builds up on the emission-free operation and promotes primarily the driving comfort. For both manual and automated transmissions, the gear shifting period during which the drive clutch is opened and the mechanical drive path is interrupted, the drive torque can be maintained via the parallel electric drivetrain. The energy required for this does not have to be provided by the battery, but rather can be generated directly from the diesel engine via the electric

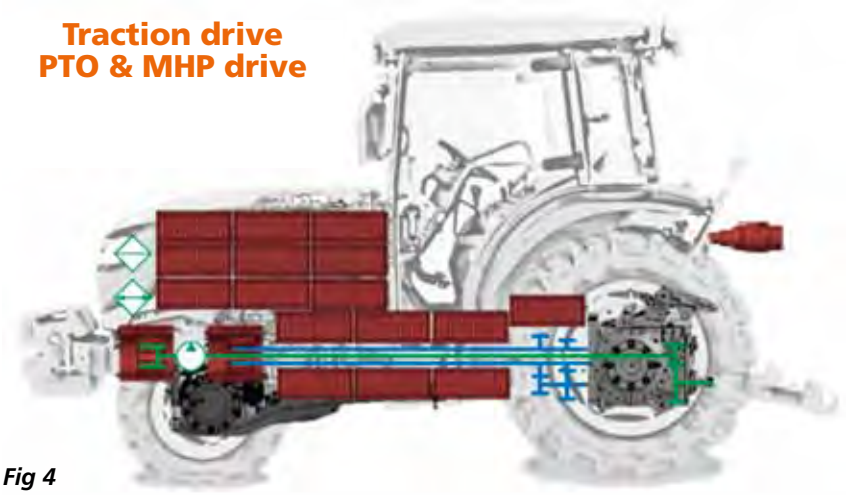


Fig 4

motor located near the engine.

On one hand the drop in speed as a result of the traction interruption can be reduced; on the other hand this can have a supporting effect on the actual gear shift so that it can be carried out more quickly and with a lower impact on the shifting components.

Likewise, a front-axle electric powertrain can have a significant impact on the agility of the vehicle by applying additional electrical boost power to the front axle when cornering by pulling the vehicle around the corner via the pull-in-turn function. Positive changes are already possible by adjusting the pre-run to the current driving situation.

By expanding the system with further storage capacity and by another electric drive unit, which can act as a second generator across both axle drives, additional applications with a higher power reduction are conceivable in full hybrid depending on the driving situation.

A demand-driven control of the cooling fan or of the main hydraulic pump enables the operation of these components in more efficient performance ranges. In addition, the reduction of the belt drive has a positive effect on the placement options of the components, so that all positions of auxiliaries follow their function and are not determined as in today's operation by the power source.

The increased battery capacity also allows the stationary power supply of electrical components, so that the vehicle can provide external equipment at standstill as well as emission-free in the function of an emergency generator. Working in self-contained halls or welding in the field are only a part of possible applications. For this purpose, it is necessary to charge the battery via a charging point, so there is no need to provide the energy by the diesel engine.

SYSTEM CONVERSION TO FULL ELECTRIC TRACTOR

In order to realize the step to the all-electric battery-powered tractor without a complete new development, manufacturers such as Fendt or Indian manufacturer Escorts used comparable concepts. Each BEV was mounted on an existing vehicle, only the components associated with the diesel engine were replaced by a central electric motor and a correspondingly large battery unit including power electronics.

The installation space under the hood was therefore replaced one by one. The electric motor is connected to the same gearbox, which is installed in the diesel-powered tractor, so that the electric motor is supported by the transmission ratio. It is important to know that the overall structure of the vehicle does not need to be adjusted so that the vehicle price can be controlled through the use of existing components.

Although the transmission can be omitted in its function by the use of a corresponding electric motor, it must be taken into account that the

Escorts electric tractor

transmission not only transmits the traction power. Rather, the transmission is designed in this vehicle class as a structural component, so that it serves as a support component for all other subsystems like the rear axle, the cabin or the front axle.

The omission of the transmission at the expense of further battery packs, as illustrated in ***Figure 4***, is therefore associated with a redesign of the vehicle structure.

Fig 5

As with the concepts of Fendt or Escorts, the installation space under the hood is used for the electric power units. Additional space is created in the area of today's transmission to install more batteries. Depending on the vehicle configuration it might be advisable to support the system by a 2-speed gearbox installed between the electric motor and the conventional rear axle.

Depending on the maximum speed of the vehicle, the electric drive is perfectly sized and the drive of a possibly driven front axle can be realized by the mechanical transmission stage. Independent of the traction drive a smaller electric motor drives both the main hydraulic pump and the PTO shaft. Both can be operated independently of the vehicle speed in their ideal speed ranges. This configuration even allows a temporary limited full utilization of traction and hydraulics or PTO. It should be noted that such a behaviour has a significant effect on the battery life and the energy storage must also be designed for larger discharging powers.

This structure differs from existing vehicles not only by the larger battery capacity. In already presented systems, the centre of gravity of the vehicle is shifted strongly toward the front axle by the heavy battery pack installed directly on the front. This redistribution can negatively affect the handling and ballasting of the vehicle. To counteract such influences, the centre of gravity displacement can be compensated by placing most of the batteries between the axles. The potentially lighter components, such as the drives and the hydraulic units, are installed in the front spaces.

However all configurations in which an all-electric drive is integrated based on an existing vehicle have the disadvantage that the wheel loads and the components are not ideally matched with each other. In addition, costs arise due to a corresponding system structure, which can hardly be justified by the given functions.

In contrast, disengaging from the conventional small tractor structure, exemplified in ***Figure 5***, allows the creation of significant machine added value, so that the economics of a fully electric system are to be reconsidered. It is not limited to one type of a machine, but rather to combine the cost-driving components, such as the electric drives, batteries or power electronics, in a base chassis, which can be used both as a basis for a tractor and for a harvesting or maintenance machine on the same power level.

Additional to the electrical power, the required hydraulic and pneumatic power is provided by the chassis so that by expanding this basic component by system implements for each application, the ideal matching vehicle configuration can be created. This avoids that, especially in seasonal work, the economic efficiency of the system is clouded by insufficient capacity utilization, but the cost-intensive components are used across applications.

The functional added value, as it is already clear today with combustion engine driven equipment carriers, can be further optimised by the integration of the electrical system. The flexibility of the electrical power take-off enables new possibilities in the vehicle configuration. A fixed internal combustion engine with non-portable shafts for transmitting mechanical power thus no longer prevents the user from adapting the vehicle ideally to the pending application.

CONCLUSION

In summary, it can be explained that, despite the increasing number of limitations that are currently emerging, the diesel engine will remain an integral part of the tractor industry for the near future. By manageable adjustments in the course of a mild-hybrid solution or a full-hybrid solution, the power of the internal combustion engine can be reduced both for the benefit of the environment and for the use of new functional potentials.

In this case, the system costs can be kept within an economic level, while the integration of such a system does not require a complete new development of the vehicle and can also rely on known structures for the user. This should always be considered as an important factor in the market implementation of electric mobility in municipal and agricultural engineering.

At the same time, fully electric battery-operated solutions should also be pursued. A construction of such systems based on current vehicle structures already shows the first possibilities of this technology, but it is far from exhaustive.

In addition, the cost-effectiveness of such systems must be questioned if, apart from emission-free operation, the vehicle can have no further functional added value. On the one hand, new possibilities open up to take advantage of electricity, if the known structure is reviewed. On the other hand, the system costs can be kept at a level that is economic for the user.

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GRAPHENE: A MIRACLE MATERIAL?

Just one atom thick but stronger than diamond, graphene's mix of mechanical and electrical properties have seen it heralded as the answer to many questions over the past decade, but the material is yet to have a commercial breakthrough. In the June 2018 issue of INGENIA, science writer Abigail Beall looked at the research that is revealing where graphene's strengths lie in industry, and where it falls down.

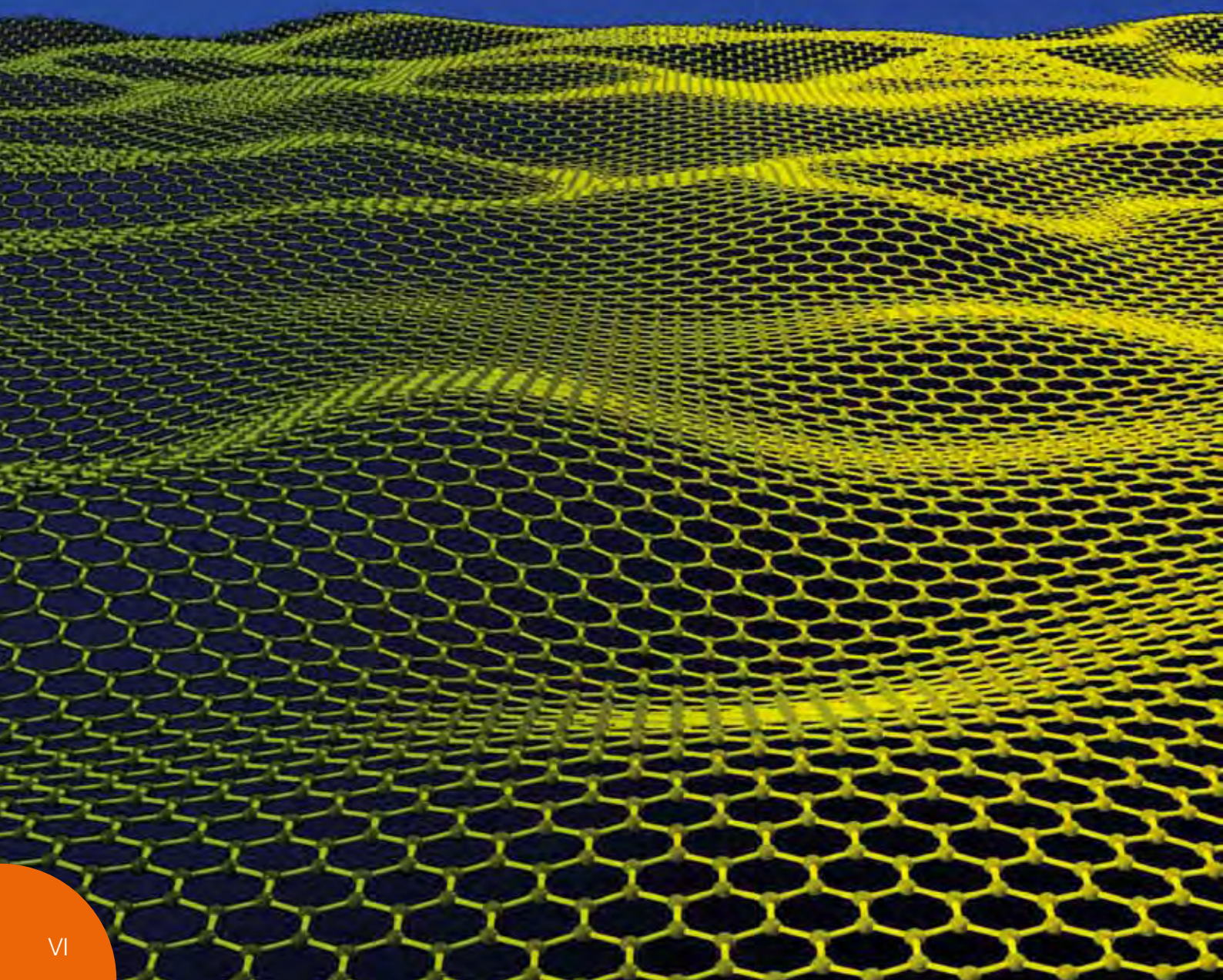
Graphene turned up unexpectedly in 2004. Its novelty and, as a new form of carbon, apparent simplicity captured the imagination of the research community.

Here was something that materials researchers could investigate with techniques that they had honed over many years, be they borrowed from work on electronics, polymers, metals or even biomaterials.

This outbreak of research into a material that promised to be "stronger than steel, harder than diamond and lighter than paper" created a deluge of publications, and press releases promoting them, that promised all manner of potential applications. In 2011, a research team at the University of Manchester, the birthplace of graphene, offered a paper demonstrating that combining graphene with metallic nanostructures showed "a 20-fold enhancement in harvesting light by graphene, which paves the way for advances in high-speed internet and other communications".

In 2014, a team at the University of Sunderland announced that it was a part of a €1 billion EU initiative, the Graphene Flagship, to "conduct a series of tests analysing the properties of graphene to determine how it behaves when it's used to enhance the advanced composite materials used in the production of cars".

There were also announcements about the use of graphene in touch-screen technology, flexible electronics, fuel cells, microwave shielding in satellite communications, 3D holograms, wearable electronics, energy storage, as a bacteria killer, to make fertilisers more efficient, and many others uses.



The interest in graphene also led to a wider focus on 2D materials (those that consist of a single layer of atoms) in general, with significant interest in finding those with unusual characteristics, for applications such as photovoltaics, semiconductors, and electrical and electronics applications.

As the attention on graphene and 2D materials waned, articles appeared in the media wondering what happened to the promise of this "not-so wonder material". Any new material – be it graphene, C60, or high-temperature superconductors, to pick examples from recent decades – takes time to move out of the laboratory into commercial use.

The material starts as a novelty that researchers have to characterise before anyone can begin to test possible new applications. Then they must devise ways of making and processing the material in commercial quantities.

In the case of graphene, these are still early days in the transition from laboratory through to production lines. One sign of the industrial interest in graphene, and the breadth of its potential applications, is the portfolio of projects that have received backing in a series of funding competitions run by Innovate UK (IUK), now a part of UK Research and Innovation [see *Industry interest*].

WHAT IS GRAPHENE?

Interest in this novel material stems from the fact that in graphene, electrons behave as massless particles, making the electronic properties of the material unlike anything seen before. The electrical charge carriers in graphene move at speeds 10 to 100 times faster than in today's silicon chips.

The material is a better conductor of electricity than copper, it is impermeable to gases, and is stronger than diamond, providing a unique mix of these properties.

According to Professor Novoselov, it was important for the Manchester team to share its discovery. There was a lot to learn about the material. The team was impatient and knew that it would have taken too long a time to investigate all the possibilities.

These days, graphene is one of several 2D materials that have significant potential for numerous products and applications.

"Graphene, and other 2D materials, have some exciting and unique properties that can potentially improve the performance of an existing product or application," says James Baker, CEO of Graphene@Manchester, a new project that is creating close ties with industry, to facilitate the development and commercialisation of products using the material.

Graphene promises to deliver lighter parts in, for example, composites for automotive or aerospace applications, or increase performance, for example creating longer-lasting or faster-charging batteries and energy-storage devices.

Other applications of the material have the potential to provide a much more direct impact on people's lives. For example, microporous graphene membranes can filter dirty salty water and transform it into safe drinking water.

It took years to develop this membrane. At first, the Manchester team discovered that when it is placed in water, a graphene-oxide membrane swells and blocks larger molecules from flowing through it. It also managed to filter out small nanoparticles, organic molecules, and even large salts. However, the filters could not remove soluble molecules such as common salts, producing a problem if the membrane was to be used for drinking water as it could not filter seawater.

"Researchers in our National Graphene Institute Membranes Lab developed a strategy to avoid the swelling of the graphene-oxide membrane in water," says Baker.

Instead of the membrane swelling, the team, led by Professor Rahul Raveendran Nair, developed a way to control precisely the pore size in the membrane. They achieved this by producing the membrane in a high-humidity environment, then using an epoxy coating to restrain the size of the membrane pores. This meant that even common salts could be sieved out of salty water, making it safe to drink.

"Creating scalable membranes with uniform pore size down to atomic scale is a huge step forward," says Baker. "It opens new possibilities for improving the efficiency – and lowering the costs – of desalination technology across the globe."

TRIAL AND ERROR

However, graphene does not hold all the answers. Not every project that has attempted to utilise the material has worked out, even for the application the team that made the discovery was trying for: to make a transistor.

Professor Douglas Paul from the University of Glasgow has made transistors from silicon, germanium and other semi-conductor materials. He says that the problem with transistors is that to build a high-performance integrated circuit, there are up to 20 performance parameters of the transistor that matter, including different voltages, capacitance, currents, power, and temperatures. Typically, there is a trade-off between several of the parameters.

Improve one parameter and it usually has a knock-on effect that makes another parameter poorer for the applications.

One such parameter is electron mobility. Transistors can be very different depending on whether there are many electrons with low mobility or few electrons with high mobility. The original papers on graphene transistors concentrated on mobility, but in the latest complementary metal-oxide-semiconductor (CMOS) technologies, mobility is less important than off-current, on-current and the operational voltage.

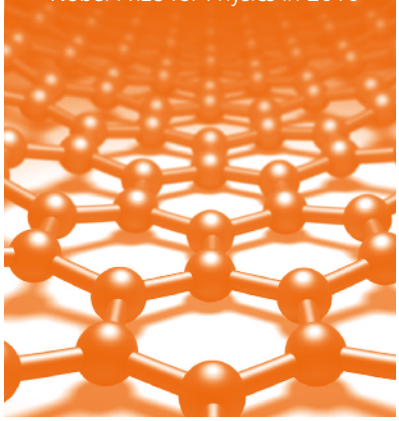
"These early papers only optimised the mobility and didn't actually address the issues of building transistors that were useful in circuits," says Professor Paul. "Later papers have got better, but the issue now is how to integrate at large scale to deliver a technology with lower cost or higher performance than CMOS and that is very difficult to achieve with the many 10s of billions of dollars spent every year to improve that technology."

Another potential application of graphene that Professor Paul looked at was photodetectors. At first it was promising. Graphene's band structure and the range of energies electrons can have in the material, means it can respond to a wide range of wavelengths of light. The fact that it is a single layer of atoms also means it responds quickly.

However, this monolayer of atoms, which is a great advantage for speed, also means that it absorbs very few photons for the shape formations that are used in most cameras, such as the mega-pixel camera in smartphones. This typically produces a very low absorption of light and quantum efficiency; two of the key parameters for photodetectors. Again, this sees a trade off in parameters required to produce the best photodetectors. Graphene has some properties that are excellent but these also lead to poor performance for other parameters.

Regardless of the outcome, graphene has presented researchers such as Professor Paul with an opportunity to try their tools and techniques on a new material. Although it has not been a key material in any of his research yet, Professor Paul says he does not rule it out completely for applications in the future. "It is worthwhile putting in all technologies that meet a certain threshold in performance across several parameters, otherwise you end up with such a long list that it is

- Graphene is taken from graphite, which is made up of weakly bonded layers of carbon
- Graphene is composed of carbon atoms arranged in tightly bound hexagons just one atom thick
- Three million sheets of graphene on top of each other would be 1mm thick
- The band structure of graphite was first theorised and calculated by PR Wallace in 1947, though for it to exist in the real world was thought impossible
- Due to the timing of this discovery, some conspiracy theorists have linked it to materials at the Roswell "crash site"
- In 2004, teams including Andre Geim and Konstantin Novoselov demonstrated that single layers could be isolated, resulting in the award of the Nobel Prize for Physics in 2010



impossible to see which technologies are the real competitors," he says.

Roadmaps such as the International Technology Roadmap for Semiconductors (ITRS), produced every few years since 1999 with input from global semiconductor makers to present the industry's R&D needs, are used to select the best technologies and concentrate developing those. For every £1 spend for research it costs £100 to get to demonstrating the technology with an application. It is then another factor of 100 to get from this point to a manufacturable product in the marketplace. Most technologies or materials in research being investigated in a roadmap for a specific application will not get to market.

Graphene is reminiscent of many other technologies that have been discovered. Gallium arsenide (GaAs), organic materials and carbon nanotubes are all examples of technologies that have gone through a similar process, sometimes described as a hype curve. At the start of any new technology, papers claim that the new material or technology is vastly superior to present technologies. This area then attracts a lot of research funding, followed by a rapid rise in the number of papers published and articles written.

"It sometimes feels like the new technology is being cited to do everything," adds Professor Paul, "even things where the performance requirements are exactly the opposite." He says this hype is produced to secure funding. Then, demonstrators appear that allow testing of applications, and it then becomes clear if a technology is competitive.

BRIGHT FUTURE?

While commercialisation of graphene has been thin on the ground so far, confidence in its properties has led to significant investment. The University of Manchester remains an important place for research into, and development of, graphene. The UK's National Graphene Institute (NGI) opened in 2015 and the Graphene Engineering Innovation Centre (GEIC) will open later this year. Both are part of the university and focus on graphene research and commercialisation. Since 2012, £61 million has been spent on the NGI, and a further £60 million on GEIC.

Cambridge Enterprise, the University of Cambridge's programme to help staff and students commercialise their expertise and ideas, has recently led a £2.9 million seed funding round for spin-out Paragraf.

A graphene technology development company, Paragraf develops electronic devices based on graphene and other 2D materials. It has already produced layers with electrical characteristics optimised for producing very sensitive detectors at commercial scale and improved efficiency contact layers for common technologies such as LEDs.

The UK government is also backing graphene. It is investing more than £120 million in "graphene research, training and development", including £40 million towards a "collaboration and investment fund", according to former Minister for Energy and Intellectual Property Baroness Neville-Rolfe, and another £50 million on a Graphene Applications Centre in Sedgefield, County Durham.

To date, the Engineering and Physical Sciences Research Council (EPSRC) has awarded grants and funding totalling more than £30 million to institutions researching graphene and carbon nanotechnology.

Looking ahead, the University of Manchester predicts the likely growth in the global market for 'graphene materials' to go from £14.6 million in 2014 to more than £285 million in 2024, and "much higher" for graphene-enabled products.

However, for all the attention that graphene has attracted since the Manchester researchers started wielding their sticky tape in 2004, researchers have just skimmed the surface of possible applications. Thousands of researchers around the world are approaching this new form of carbon from many different angles.

A ROLE IN THE AUTOMOTIVE INDUSTRY

The automotive industry has recently experienced a substantial increase in the integration of electronic control systems, with electronic components currently making up over 30% of the production cost.

Position sensors are an example of this key enabling technology to monitor and control systems throughout the car, from engine management through to pedal position. Now, customers expect intelligence as standard and at no extra cost.

Current position sensors are either contact-based devices that achieve low performance at low cost, or contactless devices where performance and cost are both higher. The EU Horizon 2020 project developed GrapheneSens to assess the feasibility of creating novel graphene-enabled contact position sensors for applications in the automotive industry, home appliances and other relevant areas, with a combined worth of over £7.4 billion.

"The unique properties of graphene are its ability to provide excellent low friction and high resistance to wear, regardless of environmental conditions – both humid and dry environments," says Dr Pufinji Obene, Operations Director at Precision Varionic International. "It can also form a barrier layer between the substrate surface and the environment, thereby preventing the permeation of liquids and gases leading to unwanted reactions at the substrate surface." Therefore, graphene could be applied successfully to contact sensors since the surface of the substrate would last a long time. The GrapheneSens project aims to combine these benefits of graphene to develop graphene-based nano-composite coatings.

To read the full text of this article from INGENIA Issue 75, published by the Royal Academy of Engineering, go to http://www.ingenia.org.uk/Ingenia/Articles/1151

BGAJ/IAgrE JOURNALISTS AWARD

ADAM CLARKE WINS 2018 AWARD FOR FUTURE FARMING FEATURE

Geoff Ashcroft runner-up for article on retro-fit auto steer systems

Freelance journalist Adam Clarke won the 2018 British Guild of Agricultural Journalists and Institution of Agricultural Engineers Award with an article examining the potential of direct injection spraying systems.
The annual award recognises the best article or broadcast highlighting the role of engineering in modern food and energy production.
Adam's winning article *'Is direct injection spraying technology about to take off'* published in Future Farming on 9 November 2017 (*reproduced here by kind permission of publishers Reed Business bv).*
IAgrE chief executive Alastair Taylor praised the high standard of entries as he presented Adam with £750 and a commemorative trophy for winning the award.
Alastair said: "Adam's piece was well researched, clearly written and included useful panels on the available pros and cons of direct injection spraying systems."
The award was presented at the Guild's annual Bangers 'n' Beer reception, held at the Cereals event on Wednesday, 13 June.
Runner-up in the award was Geoff Ashcroft for an article on retrofitting auto-steering systems to older tractors, published in Farmers Guardian in July 2017. Judges said the article was useful for farms wishing to stay up to date without the need to make a big investment in new machinery.
Read Adam Clarke's winning feature overleaf

(Top right) Adam Clarke receives Award from IAgrE CEO Alastair Taylor with Guild Chairman Catherine Linch

(Right) Geoff Ashcroft receives his Award

Is direct injection spraying technology about to take off?

Direct injection spraying systems have been around for years, but never really gained much popularity. Future Farming finds out why and asks if it might be about to gain traction as farmers shift to a more high-tech approach to pesticide application to cut cost and environmental impact.

By Adam Clarke

Agricultural engineers have come up with all sorts of innovative solutions to farmers' problems over the years. Some hit the big time and are seen on farms the world over, while others flop and end up banished to the back of the shed to gather dust.

Then there are those in between – technology that lingers in the background, finding a handful of niche uses and limited adoption by hardcore enthusiasts.

Direct injection systems for sprayers fit into the latter category, having been around since the early 1980s, but never truly taken off.

However, agronomic and environmental concerns, combined with a drive to cut costs, could be about to trigger a slight resurgence in the technology, although some significant barriers need to be overcome first.

SIMPLE CONCEPT

So, what is direct injection? The concept is simple and makes perfect sense: you have a "carrier" tank – typically water – and one or more chemical tanks.

Each chemical tank has a pump that injects neat pesticide at the desired rate into the carrier in a pressurised spray line before reaching the nozzles.

In principle, direct injection systems have several advantages, the first being a simple rinsing process.

The chemical flow is switched off and clean water runs through the contaminated lines to clear them out, leaving the operator with a clean slate for the next crop.

There are no washings to dispose of and it reduces overall residue build-up in the system, cutting the risk of compromising crop safety.

This is particularly appealing on fresh-produce units where a high number of crops can be planted sequentially or in small plots, requiring operators to frequently switch products or mixes.

With a direct injection system on board, this can be done from the cab with a flick of a switch and systems on the market today can carry five or six products at once, offering a high degree of flexibility and significant time savings to boot.

In addition, no measuring of product is required, so once the desired chemicals are on board, operators may only need to top up the main tank with water over the course of the working day.

Direct injection systems save money and offer environmental benefits too.

Operators can use application maps to spot spray products just where they are needed for a specific weed, pest or disease problem, cutting overall pesticide use and the farm's chemical bill.

Some would also argue that while transporting a laden sprayer on the road, if an accident were to happen, a small spillage of concentrated pesticide is easier to contain than thousands of litres of tank mix running down the road.

These are all admirable advantages and begs the question, why aren't there more direct injection systems in use?

HIGH COST

The first drawback is cost. John Deere offers the market-leading Raven Sidekick Pro system as a dealer-fitted option on its Des Moines, US built self-propelled machines.

The firm quoted Future Farming a price of $58,000 for a four-pump system, equating to between 15-25% of the price of the sprayer itself and a hefty investment by anyone's standards.

Second, despite the concept being simple, direct injection systems – which are mostly retrofitted – place a heap more complexity on a sprayer, its operator and the service dealer, which often don't have the expertise to offer the best after-sales support.

This has, in some cases, led to reliability issues and reduced trust in the concept, leading to a history of farmers who have tried, failed and ultimately ditched direct injection.

VARIABLE PRODUCTS

Makers of direct injection kits have also struggled with product variation. Liquid pesticide formulations come in a huge range of viscosities and levels of abrasiveness, so have the potential to compromise reliability and accuracy of application.

It has also been difficult to find a solution that accurately meters dry formulations, such as wettable granules or powders.

Perhaps the biggest problem, however, is operator exposure – something that is under the spotlight and regulators are trying to eliminate where possible.

With direct injection systems, there is a need to pour neat chemical into holding tanks and if emergency maintenance of injection lines is required, exposure can be increased further.

Finally, there are still all the containers that need rinsing and the injection system will need flushing from time to time, so you still have plenty of

contaminated waste to deal with.
So, with both pros and cons to direct injection, what lies in store for the technology?

INCREASING DEMAND

Demand is growing in North America. It is driven by weed resistance problems in GM Roundup Ready crops, with growers looking to spot spray different herbicides to help control tough-to-kill weeds.
Danish sprayer manufacturer Danfoil also reported a small rise in demand for direct injection technology in the past three years across Europe, particularly in Germany.
This could be down to some of the flaws attributed to the system being addressed, with companies such as French start-up Diimotion leading the way.
Its PiiX direct injection system has a unique patented dosing unit that claims to have higher accuracy (about 1% variation) than dosing pumps (about 5%) used on more established systems.
It also maintains this accuracy regardless of liquid formulation, aided by pressurising its chemical tanks to 0.5bar (7psi), and they have even developed a way to accurately meter and inject powders to within 5% accuracy.

VARIABLE RATE

In addition, the firm is working on a new valve that will enable real-time variable-rate application on wide booms. It is hoped this will allow the use of sensors to recognise weeds and disease and automatically apply the right spray for the job, exactly where it is needed.
So far, its system has only operated in vineyards or horticultural systems, but CEO Xavier Cassassolles believes the PiiX's biggest market will be on broadacre-crop farms looking to vary rates to save chemicals.
Similarly, Danfoil is involved in a $2.9m project, run by the Danish government, universities and industry, which is building up a huge digital image database of weeds at all growth stages in different conditions.
It is hoped sensing drones can then be used to scan fields ahead of a sprayer fitted with direct injection technology, spot spraying or varying dose according to weed spectrum and levels on the move.
Variable-rate fertiliser and seed is already the norm on many farms, so it seems translating this into pesticide application is where we will see the real growth for direct injection systems – helping cut costs and use pesticides more judiciously.

GAME CHANGER

However, there is a sense any game changer for the concept rests with the big sprayer and agrochemical manufacturers.
Sprayer manufacturers need to see demand increase before it becomes worthwhile to offer in-house systems for established sprayer models – which is key to gaining widespread trust in the technology among farmers.
Agrochemical manufacturers need to come up with a standard packaging solution that incorporates reusable closed-transfer technology to eliminate operator exposure and contaminated waste at farm level.
A fully integrated approach between agchem and applicator makers has already made direct injection standard for in-furrow applications on potato planters, with products such as Amistar delivered in a returnable 20-litre closed-transfer "Link-Pak".
Once this concept is transferred over to large boom sprayers, perhaps direct injection will be the next technology to hit the big time.

WHAT ARE THE OPTIONS?

Raven Sidekick Pro: The global market leader in direct injection systems. Some sprayer manufacturers offer the Sidekick Pro as a factory- or dealer-fitted option. A four-pump system for a US-built John Deere machine retails at US$58,000.

Danfoil Multidose 2000: Danish sprayer manufacturer Danfoil offers sprayers from 1,000-6,000 litres (264-1,585gal) fitted with its own direct injection kit (pictured), developed over 17 years. The system offers up to six dosing pumps with a margin of error of less than 5%. A 3,000-litre (793gal) Concorde trailed sprayer with five chemical dosing pumps retails at about $177,000.

DiiMotion PiiX: French start-up DiiMotion's PiiX system can be bolted on to any sprayer for $21,000-$26,000 depending on specification. The firm will also be marketing a 12-15m (40-50ft) mounted sprayer for horticultural use for about $35,000, capable of injecting up to four liquids plus one powder.

Teejet Aeros: Like Raven, US spraying technology firm Teejet offer a retrofit system through their dealer network that can be installed on any sprayer

Direct injection systems

Pros

- Water and chemicals kept separately
- No washings generated between jobs
- No residue build-up in main tank or spray lines
- Select from multiple products at the flick of a switch
- Enables spot and variable-rate spraying to reduce pesticide use

Cons

- High cost and complexity of retrofit systems
- Lack of adequate after-sales support
- Problems with variation in chemical formulations
- Container and injection system rinsing generates contaminated waste
- Lack of standard packaging with closed-transfer capability to reduce operator exposure

The path ahead

- Agrochemical manufacturers need to agree on packaging solution. Major sprayer manufacturers must integrate closed transfer into designs
- Push for variable-rate pesticide application will drive demand.

Feedback

Responses to **Landwards** Feedback to the Editor chris.biddle@btinternet.com

£10m TO SAVE OUR SOILS

Dear Editor,
I'd like to make some comments on the article '£10m to ***'Save our soils"*** on page 6 of the Summer 2018 edition of Landwards.

It is good that WWF-UK, in association with The Angling Trust and The Rivers Trust has published ***'Saving the Earth. A sustainable future for soils and water'***. WWF-UK is yet another body that considers we are not looking after our soils with sufficient care. I would not disagree and agree with much of what the article says. But, it seems to me, that many organisations concerned with the environment, as well as the government in its recent 'Health and Harmony' consultation and accompanying evidence compendium (Defra, 2018[1]), in their wish to reform farming policy after the UK leaves the European Union, do not take into account sufficiently how we have arrived where we are with regard to treating our soils.

Farmers are being castigated and their economies threatened. They are doing what they have been asked to do and farmers understandably will object to the phrase "poor farming and land management practices" because they are following the advice they were given.

The leaving of the European Union has encouraged those who think our leaving might be a good thing because it will give the UK the chance to farm our land in a more sustainable way. But the way we farm is an outcome of what governments and commerce wanted and have taken farmers down the route of intensive farming, more fertilisers and pesticides, larger machines and larger fields to accommodate them.

The reasons go back to WWII and the threat of starvation. Intensification to grow more food came in before we joined Europe. I started monitoring soil erosion in the 1960s. The likely outcome of leaving the European Union is that farmers may well not be able to farm profitably without some form of subsidy on a par with (or, for the uplands, better than) now. It seems unethical to me that farmers should be paid to take one route and then lose out because the government changes its policy.

Much of what we read about the loss of soil by erosion with the threat to crop productivity as the soil thins is not relevant to the UK. The loss of the soil as a resource over the short-term is minimal. And no-one knows, worldwide, what actual rates and extent of erosion are. In Britain we may well have the best information on the rates and extent of erosion of arable land in the world, based on field assessment, not plot experiments.

Mean rates of erosion are very low, for example, the widely quoted figure of 2.9m tonnes of soil lost a year, when put back on the land is <0.2mm a year. Unless a farmer has a large rill or gully (not crossable by agricultural machinery), s/he will understandably not notice or bother about erosion. Coloured runoff out of fields does not necessarily mean large amounts of soil are being lost. Also, sediment in streams, taken as an indicator of soil erosion, can come from many sources other than farmers' fields – river bank erosion, ditch cleaning, roadside verges.

The short-term problem in the UK is not loss of soil but water quality – nutrient-rich streams and pesticides above the legal limit in water bodies mean water treatment costs are high, and even then not all pesticides are removed. Sediment in streams affects fisheries.

The reason for first assessing soil erosion was seeing rills and gullies in farmers' fields – was it a problem? It is ironic that it is the hard to see signs of surface wash, unless you are out in the rain, which is the problem. Wash carries pollutants and fine sediments, especially down tractor wheelings to ditches, streams and rivers. Such wash can happen many times a year (5-10mm rainfalls). If there is 'driver' in the system such as a rapid increase in gradient at the edge of a ditch or stream, the distance between ditch and stream and adjacent slope is of little relevance for when soils are saturated surface flow will cross grass margins. Field drains once flowing react rapidly to even small rainfall events. Flooding of property by sediment-laden water is another serious problem, especially if it's from a field of outdoor pigs.

Farmers should address these problems, and be supported financially to do that. And policy makers need to understand that it will take time for mitigation methods to reduce diffuse pollution from farmland to have an impact.

I am writing this letter to ease my frustration that although I agree with much that the sustainable farming lobby would wish, the lobby does have to take on board that it is not just farmers who are the problem but all those who, understandably, after WWII, indeed from time immemorial, have wanted a cheap food policy.

The comments above are made in the light of knowing that food prices are likely to have to go up, and that the poorer parts of societies will be hit hardest. But these enormous social problems need to be worked out – no easy task. At some point, hopefully before too long, these problems will have to be faced and tackled.

Yours sincerely,
Bob Evans
Global Sustainability Institute
Anglia Ruskin University

(1) Defra. 2018. Health and harmony: the future for food, farming and the environment in a green Brexit. Cm 9577. London; and its accompanying The future farming and environmental evidence compendium.

DOUGLAS BOMFORD TRUST

The Douglas Bomford Trust,
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@BomfordTrust Secretary: Alan Plom
Administrator: Elizabeth Stephens

Alan Plom, Secretary to the Douglas Bomford Trust (DBT) reports on another busy few months for the Trust, not least because it has been *The Awards Season:*

MONITORING AND MENTORING

Our Trustees have also had several interesting and informative project review meetings to provide advice and ensure progress and cost-effective use of DBT's funds. These included a meeting at **RAU** with Malcolm Crabtree (DBT's Chairman), Paul Miller (Trustee) and Karen Rial-Lovera, the DBT-funded Chair of Agricultural Engineering. This post has brought a new focus on the profession at RAU and further opportunities for collaborative working are being identified.

The Trustees half-yearly Management meeting was held at **Reading University,** when we also heard about Reading's projects and plans. **Lincoln University** was also visited to explore current and future work. More on their projects in future DBT Updates.

We also subscribe to support the **Agri-Epi Centres** and Paul Miller outlined the Trust's role at their Annual Stakeholder Day at Cranfield on 27 June. More than 60 representatives from leading academic and agri-food industry partners, technology providers, etc, attended this valuable networking opportunity, intended to 'build the Agri-EPI member community' and to stimulate new partnerships. It included a tour of Cranfield's Precision Agriculture and Soil Health facilities. (https://twitter.com/agri_epi)

The Trust also paid for 3 HAU Engineering MSc students to attend the international **Field Robot Event**, held in mid-June at Bernburg, Germany. Although *'ERIC_the_Robot'* was a potential front-runner in testing, unfortunately various gremlins (technical and rules) intervened during the competition. However, the team still felt it was a great learning experience and have many tips to pass on to their successors. Read more about their project on Twitter: *@ERICHAU4*

ABOVE: Eric the Robot HAU's Alex Fisher, Rhys Thomas, and Megan Platt with ERIC (the Robot).

WOMEN IN ENGINEERING

HAU's 'e-News' recently reported on **Amy Boothby**, one of DBT's Scholars on the BEng (Hons) Agricultural Engineering course. Amy said: "Receiving a Douglas Bomford Trust Scholarship is brilliant. I'm going to spend some of the money promoting women to consider a career in engineering…."

Amy was influenced by a school visit to Jaguar Land Rover when, in her words, she was: "Beyond surprised, and my perceptions around engineering were completely changed. I realised that engineering could involve being at the forefront of innovation and solving tomorrow's problems today.

The engineering I study is about designing things, solving problems and making things better for future generations of farmers, so they can keep supplying the world with food."

Amy's aim aligns with the objectives of the Trust and I am sure that **Prof Jane Rickson**, the recently appointed (and first female) President of IAgrE will no doubt approve too. You can read more about what inspired Amy to take up her personal challenge and view on the benefits of employing female engineers at https://www.harper-adams.ac.uk/news/203238/ .

IAgrE 2018 AWARDS

Douglas Bomford's legacy was evident at IAgrE's 80th Anniversary celebration, held at Wrest Park on 24th May. Several speakers and recipients of awards recalled and thanked DBT for the support they have received from the Trust, which was founded in 1972, this included:

- ***Clare Butler Ellis*** (Research Manager, Silsoe Spray Applications Ltd), who received DBT's 'Best Paper' Award for her contribution to a paper on modelling bystander and resident exposure to pesticides, published in **Biosystems Engineering**, Feb 2017.
- ***Michael Giannitsopoulos*** also paid tribute to the support given to him by the Trust when collecting the **CNH Industrial Award** for his **Cranfield University** thesis on optimising conservation tillage systems.

AGRI-FOOD CHARITIES (AFCP)

New Midlands Group

Alan Plom presented an update on the work and philosophy of the DBT at the inaugural meeting held at Harper Adams University (HAU) on 12 July, to stimulate closer understanding and collaboration between food and farming charities, societies and organisations operating in the Midlands. There are now around 150 charities nationally providing funds in the agri-food sector listed on the **AFCP website**.

Peter Mills (HAU's Vice Chancellor) outlined how charities are supporting new research and knowledge transfer and gave an overview of HAU's activities. Kim Matthews, (AHDB) described the needs of the industry and support given by charities to agricultural research. Other organisations represented included AHDB, RASE, PGRO, the Worshipful Company of Farmers, British Grassland Society, Shropshire Chamber of Agriculture and several 'Foundations' and other Trusts.

MEMBERSHIP ENQUIRIES
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2018 LANDWARDS CONFERENCE PREVIEW

Tuesday 6 November 2018 Royal Academy of Engineering, Prince Philip House, 3 Carlton House Terrace, London SW1Y 5DG

ENGINEERING COLLABORATION FOR SUCCESS: *Best Practice for Knowledge Exchange in Agricultural Engineering*

As Agricultural Engineering evolves to become even more critical to food security under a modern industrial strategy, the need for better knowledge exchange has never been more important.
More than ever, in this 80th Anniversary year of the Institution of Agricultural Engineering, the need for industry and universities to collaborate on ground breaking technologies and revolutionary new practices is vital.
This unmissable Conference will seek to answer important questions.
The conference will explore examples of successful collaborations in engineering between commercial, industrial, research and academic partners.
You'll hear from senior engineers with experience of successful knowledge exchange who will share their expertise and experiences.
This conference is for everyone interested in bringing new technologies and innovative know-how into the agricultural supply chain, including engineers, scientists and technologists, farmers, growers, producers, and policy makers.

- How can collaboration in engineering work?
- What does success look like?
- What can go wrong and how can we avoid the pitfalls?
- What barriers need to be overcome before new practices impact on the end-user?

PROGRAMME

MORNING SESSION

What is Knowledge Exchange and why is it important?
Professor Jane Rickson, Cranfield University and President, IAgrE

Jane is Professor of Soil Erosion and Conservation in the Cranfield Soil and AgriFood Institute, School of Water, Energy and Environment at Cranfield University. She has specialised in land resource management at MSc and PhD level. Her work has focused on the assessment, monitoring and management of soil resources to advance understanding of soil functions and their role in the delivery of ecosystems goods and services. Jane works with individual farmers, grower groups, agribusinesses, Research Councils and policy makers at local, national and international level.

The End User: the true beneficiary
Dr Susannah Bolton, Knowledge Exchange Director, Agriculture & Horticulture Development Board

Susannah is a highly experienced research manager and communicator of science. Most recently she has been

Head of Crop Production Systems at AHDB responsible for managing a large portfolio of R&D projects and associated knowledge exchange activities. Previously Susannah worked at Rothamsted Research in Hertfordshire, where she was responsible for the development of international research projects, science communication and knowledge transfer activities.

The Knowledge Transfer Challenge
Keith Norman, Technical Director, Velcourt Ltd

Keith graduated from Newcastle University specialising in Crop Production. Keith then followed a career in practical farm management for 6 years becoming arable manager on a 1200 hectares estate in Lincolnshire. Keith then changed to a more technically based role as Technical Director, supporting Velcourt's team of 45 farm managers in crop production technology and managing Velcourt's in-house research and development activity in 1989. Velcourt currently manage 53,000 hectares in the UK.

Making Collaboration Work
Professor Keith Ridgeway CBE, Executive Dean, AMRC Group

Keith is the Professor of Design and Manufacture and Executive Dean of the AMRC at the University of Sheffield. The AMRC comprises the AMRC with Boeing, the Nuclear AMRC and the AMRC Apprentice Training Centre. The AMRC with Boeing was established in 2001 to carry out research in manufacturing technologies directly related to the aerospace industry. In addition to Boeing, the AMRC has more than 100 sponsors, including Airbus, BAe Systems, Rolls-Royce, Messier Bugatti Dowty, Goodrich and Spirit Aviation.

Opportunities for Knowledge Transfer in Agri-Tech
Chris Danks, Knowledge Transfer Manager - KTN

Chris joined the KTN as a Knowledge Transfer Manager in the Agriculture team in September 2015. Prior to this Chris was CEO of Forsite Diagnostics a spin out company that culminated twelve years research as part of the Plant Health Team at FERA, pioneering the use of field test kits for the detection of plant pathogens. Chris has taken a lead, within the Agrifood team, to focus on Agri-Tech Investment showcasing, and building a community of active Agri-Tech investors.

AFTERNOON SESSION

COLLABORATORS: THEIR EXPERIENCES
Short presentations from a number of current industry and research collaborations where Knowledge Exchange has been developed, leading to successful outcomes - to be followed by a 'round-table' discussion and Q and A session.

Hands-Free Hectare Project
Kit Franklin (Harper Adams University)
Clive Blacker (Precision Decisions)

The Harper Adams University/Precision Decisions "Hands-free Hectare" project has drawn much interest from many people and is a great example of a successful partnership. Kit and Clive will explain the partnership and how this has made the project a success as well as drawing much interest across the Globe.

Best Practice for the Food Industry
Prof Simon Pearson (Director of LIAT, Lincoln University)

Lincoln University has built up a reputation for its work with a range of partners from the food industry – particularly post-harvest and the intensive crop production and vegetable growing sector, much of this driven by work on digital technology and robotics. Simon will showcase some of his work and explain how partnerships have been used to develop best practice.

Understanding soil tillage
Iain Dummett (PhD Research Student, School of Energy, Environment and Agrifood, Cranfield University)

Iain has recently completed his PhD in soil science at Cranfield University. His research focussed on evaluating options for achieving strip tillage, including a specialist strip tillage implement and use of subsoilers. The common thread through this research was a desire to understand how tillage intensity and the associated crop performance benefits can be maintained, whilst the surface area of soil disturbed is decreased.

NEW IAGRE MEMBERSHIP BENEFIT

A financial safety net could make all the difference

Have you considered how you would cover your monthly expenses including your mortgage or rent, food shop or other bills should you be unable to work due to unexpected illness or injury?

How would this impact your family's finances? If not, you're not alone.

However, the impact could be greater than we think. The government's statutory sick pay may come as a shock. It can be as little as £92.05 per week – depending on your circumstances. For most, this wouldn't begin to cover what's needed to get by.

That's why we have partnered with PG Mutual to offer Income Protection Plus at a discounted rate for our members.

Income protection covers a share of your income if you are unable to work through illness or injury. For instance, PG Mutual policies can cover up to 70% of your income (up to £1,200 per week) while you take the time to recover - without the added burden of financial anxieties.

As well as paying out on 98% of all claims, PG Mutual gives their profits back to policyholders. When you join, they create an investment account for you that's topped up annually from any profits they make and there's no penalty for making a claim against your policy.

Other highlights of the policy include:

- No penalties for claiming and no restrictions on the number of claims you can make.
- Cover can start from the first day you are incapacitated and lasts until you recover or until you reach age 65 – whichever comes sooner.
- Enhanced Loyalty Bonus that aims to pay a minimum of £10,000 and six months income benefit to your family in the event of your death.
- Access to GP 24/7 app which allows you to schedule a GP consultation at the touch of a button and access to a confidential Telephone Counselling and Helpline Service with qualified professionals – all currently free as part of your membership with PG Mutual.
- Access to a Member Benefit scheme that currently gives you free access to a fantastic range of exclusive discounts/cashbacks and offers on popular brands and services.

Find out more about Income Protection Plus by visiting ***www.pgmutual.co.uk***.

Be sure to use code '**IAGRE18**' to receive 20% off your first two years' cover.

Plus, if you join them by the 31st October, you will receive **a £25 high street voucher***.

*For full terms and conditions, visit www.pgmutual.co.uk/terms-and-conditions.

BREAKING DOWN DIVERSITY BARRIERS IN ENGINEERING

New programme aims to increase transition of ethnic minorities into engineering

Amy Boothby, an Agricultural Engineering student at Harper Adams University and now on the IAgrE Council and Sarah McLeod from the Secretariat attended the launch of a new Graduate Engineering Engagement Programme at the Royal Academy of Engineering in June.

The programme aims to enable more ethnic minority, female and socioeconomically disadvantaged engineering students to move successfully into engineering jobs - with a focus on those from the newer post-92 universities.

The State of Engineering 2018 report from Engineering UK found that 12% of the UK working age population are from Black, Asian and minority ethnic (BAME) backgrounds, but only 8% of professional engineers are, despite the fact that 27% of engineering graduates in 2016 come from ethnic minority backgrounds. According to Academy research, employment outcomes of engineering graduates are more than twice as likely to be unemployed six-months post graduation, than their white counterparts of similar age and gender with similar study and degree classifications.

The Graduate Engineering Engagement Programme will work to address these and other disparities by connecting engineering graduates, undergraduates and businesses, and by working to minimise barriers that have a negative impact on the transition of underrepresented groups into engineering employment.

The Academy-led programme is based on a three-year pilot that engaged more than 450 engineering students. The pilot was actively supported by a collaboration of 14 engineering businesses and delivered in partnership with Sponsors for Educational Opportunity (SEO) London – an organisation with an eighteen-year track record of preparing talented students from ethnic minority or low socioeconomic backgrounds for career success. Early indications from the pilot are encouraging, with 15 placements, 38 internships and 38 graduate roles secured. Full results will be available once all students have graduated in the years to come.

To coincide with the launch of this programme, the Diversity and Inclusion Leadership Group - the Academy's network of engineering employers working on these challenges - has released an inclusive recruitment practice toolkit freely available for use across the engineering profession and beyond.

Bola Fatimilehin, Head of Diversity and Inclusion, Royal Academy of Engineering, said;

"Working with so many enthusiastic engineering employers to design and deliver a three-year pilot to increase the transition of ethnic monitory, female and socioeconomically disadvantaged students into the profession has been fantastic.

Now that the Graduate Engineering Engagement Programme is a permanent feature of Academy work, even more employers are coming on board. Together we will make engineering the career destination of choice for all engineering graduates and at the same time increase diversity and inclusion across the profession."

John McCollum, Engineering Director, BAE Systems, which participated in the pilot programme, said;

"The programme has given us direct access to a wider, more diverse, range of engineering students, including those who may not have immediately thought of a career with BAE Systems."

REPUBLIC OF IRELAND BRANCH

Grass and Muck Event
Gurteen Agricultural College
Co Offaly
17 May 2018
Report by David Frizelle

The IAgrE Republic of Ireland Branch acted as the co-ordinator for a stand at the Grass and Muck event under the title, *'Agricultural Engineering & Mechanisation, Education & Training'*.
This year we were joined, once again, by the Agricultural Engineering Dept from I.T.Tralee, and two new exhibitors, Ballyhaise College from Co Cavan, and Kildalton College from Co Kilkenny.
Ballyhaise College was promoting the Higher Certificate in Agricultural Mechanisation, Level 6 which they intend starting in September 2019.
Kildalton College, was also advertising their Advanced Certificate in Machinery & Crops Management, which they run being situated in a part of the country where arable farming is a major enterprise.
Almost 12,000 people attended this year's one day event , organised by the Farm Tractor & Machinery Trade Association, (FTMTA).
There was a wide range of silage making equipment in action, including mowers of all types, rakes , tedders, balers, wagons, trailed harvesters and self-propelled foragers. The slurry spreading, dung spreading and reseeding demonstrations also proved popular.
There were also a considerable number of trade stands, and we were fortunate to be allocated a central position which resulted in a lot of attention, especially when free teas and coffees were on offer.
All the Colleges reported a strong interest in their courses and were pleased with the response and facilities available.

Representatives from I.T. Tralee, Ballyhaise and Kildalton Colleges

Pat Carney, Dave Frizelle, Francis Quigley and Ger Griffin

NEW IAgrE MEMBER BENEFIT

*Save up to **40%** off your Cinema Tickets*

We're delighted to have teamed up with The Cinema Society and to be able to offer you up to 40% off the cost of your cinema tickets.

All you need to do is register with The Cinema Society, set a password and you can log in as often as you like and save money on your cinema tickets.

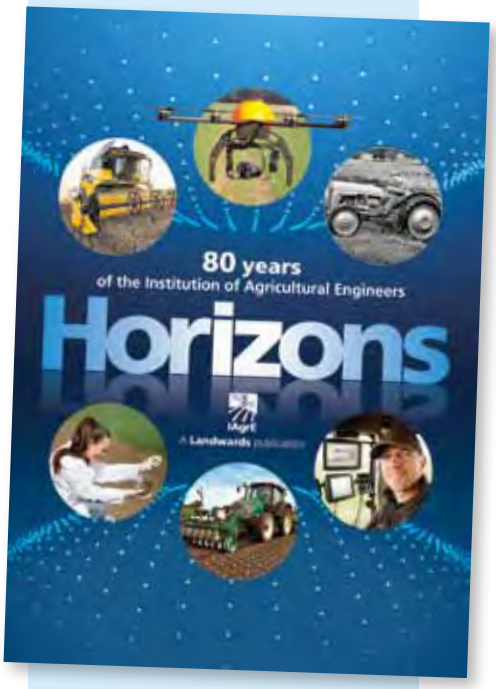
For full information login to the IAgrE website and follow the link to the Cinema Society page from the Discounts area.

COMING SOON

SPECIAL PUBLICATION

On 24 May 2018, IAgrE marked the 80th Anniversary of its formation by holding its AGM and Annual Awards at Wrest Park, Silsoe, the headquarters of the National Institute of Agricultural Engineering from 1947 until its closure in 2006.
To celebrate this milestone, IAgrE is compiling a special publication charting the extraordinary evolution of machinery, equipment, science and technology over the past 80 years. – with a look forward to likely developments over the coming decades.
The publication will reflect IAgrE's sphere of influence in agriculture, horticulture, forestry, dairy, soil science and the environment through the eyes of leading engineers, academics and industry experts.
The publication**, HORIZONS**, will be launched at the **2018 Landwards Conference** at the **Royal Academy of Engineering** on **6 November 2018** – and will be circulated to members with the Winter issue of Landwards in December.
There are advertising opportunities available in this special publication which will surely be kept and referenced for many years.

FURTHER INFORMATION FROM CHRIS BIDDLE, EDITOR, LANDWARDS chris.biddle@btinternet.com or phone 01722 327277 or 07785 295625



AGM and Meeting
Stage V Engine emission and beyond
Presented by Kubota UK
Royal Agricultural College, Cirencester
14 March 2018
Report by Mike Whiting

The Western branches AGM on the 14th March was followed by a double act of engine technology updates from Andrew Wolton, Account Manager for Kubota UK's engine division, and Rob Edwards, Business Development Manager for Kubota UK's Agriculture division.
In the power unit manufacturing arena, a "wolf in sheep's clothing" has arisen to become a formidable force in providing engines to a range of industries. Where Kubota would once be associated with the small compact tractor range, its business interests as an engine supplier to end users extend into construction, aviation, power generation, turf care and other prominent industries.
Andrew explained that Kubota's engine production roots started in 1922 with their type A unit, producing 3hp. Fast forward to current times, the Japanese factories are producing one power unit every 34 seconds. Toyota falls 2nd in line with outputs at the 75 second mark.
Remember the KANBAN principle of optimising of supply chain management? Clearly this is applied in earnest within the Kubota engine manufacturing division, although this exacting level of detail is driven down through third party suppliers. Take a look at Kubota's purchasing contractual arrangements and the reference to "outstanding quality", delivery on time and product innovation are clear, in other words if their component suppliers had a tattoo, there'd only one significant colour required; orange.

So what does designing an engine to meet Stage V actually mean? With all legislation there's a recognised body which dictates such requirements, and in this case it's the Swiss and US who signed off to set the ball rolling.
The key thread through both Andrew and Rob's presentations is that essentially it's all to do with reducing particulate matter to the threshold of 0.025g per KW output. This further drop in the limbo dancing bar challenge for engine manufacturers brings the diesel particulate filter into the specification for the 25hp – 50 hp engine.
Just referring back to Kubota's prominence in the compact tractor range, the resulting impact is a complete redesign of the tractor to accommodate the new engine. Stage V isn't a complete revamp of engine design it's tweaking what's already there. For example the diesel particulate filter (DPF) is a definable feature on any modern tractor. To further reduce particulate matter emissions the core density is increased, without expanding the cross sectional area. Although Kubota has a few other tricks up their sleeves.
The DPF traditionally sends a signal to the tractor dashboard informing the driver that a build-up of engine revs is required to clear the system. Kubota's research and development has deduced that the implementation of a part regeneration phase at an earlier stage will avoid a heavy soot loading.
Consider the hiring of machines to construction sites, where engines can run for many hours on tick over.
Keeping the DPF clear at the end of hire ensures the machine is supplied to the next customer ready to operate efficiently and uninterrupted.
All of this constant re-engineering to meet environmental targets has come at a cost, principally to the end user. Rob Edwards gave a quick overview of tractor purchase costs over a decade under the ever reducing environmental targets.
In addition approximately 60% of engine manufacturers R&D have been dedicated to meeting emission targets. So where next in the legislative ballpark of challenging air emitted from the exhaust valve? Stage VI was briefly referred to for high capacity harvesters, although what really caught everyone's attention was the reference to the spark ignited engines.
The availability of new fuels from bio-digestate plants such as methane ticks many boxes on the green auditor's checklist, although it poses a whole raft of new challenges on the complete tractor design. This is in addition to considering the torque output of modern petrol engines, which suddenly pulls the rug out from beneath the heavily laden post ignition diesel residues.
Kubota has recently unveiled its 5 litre engine due for worldwide production release from 2020. This initiative to advance sell the concept into the market demonstrates the "wolf" hasn't lost its appetite.
Wherever the line is on the graph for engine emission targets over the next decade, the Japanese manufacturer's strapline demonstrates they have it covered; ***Kubota; the Answer***.

	Year	
Engine profile	2015	2018
100hp 4 wheel drive unit	£23,000	£41,000
150hp 4 wheel drive unit	£55,000	£92,000

IAgrE SUPPORTS THE WORLD AGRI-TECH INNOVATION SUMMIT IN OCTOBER

Held annually in London and San Francisco, the 2018 World Agri-Tech Innovation Summit will be held at the Tower Hotel, London on 16-17 October. The event is an international networking and deal-making meeting place for global agribusinesses, solution providers, entrepreneurs and investors. The aim of the summit is to accelerate the commercialisation of advanced agricultural technologies by generating global partnerships and collaborations and to forge the right partnerships to take these solutions to market.

BUILDING AGRI-FOOD SYSTEMS FIT FOR THE GLOBAL CONSUMER is the key theme for 2018

- Smart Farming: Low Cost Outcome-Based Models for Precision Ag – Tackling the Adoption Barrier
- The Power of the Microbiome in Restoring Soil Health
- Microbes, New Chemistry & Integrated Platforms: Farming's New Approaches to Crop Protection
- How Small Companies are Leading the Revolution in Gene-Editing
- Putting Robotics and AI to Work in Agriculture
- Supply Chain Traceability: Tech-Enabled Food Quality from Seed to Table
- Scaling Agri-Tech in Ukraine, Russia, India and Africa
- Indoor Farming: Hyper-Efficient Horticultural Production to Nourish the Cities of Tomorrow
- Investment Opportunities in Animal Health

Amongst the speakers will be Professor Simon Blackmore and Jonathan Gill from the Hand-Free Hectare initiative. Details https://worldagritechinnovation.com/

WEST MIDLANDS BRANCH

PIONEERING TECHNOLOGY SPECIAL INTEREST GROUP (PTSIG)
Visit to the David Hulse collection of models
Saturday 16 June 2018
Report by William Waddilove

Gasps of 'Ooh' and 'Ahh' and 'Oh what detail' were heard coming out of the front room at David's house as we were assembling at the start of the visit.
To go back to the beginning, we all know that Thomas Newcomen is credited with creating the first working steam engine (although really an atmospheric engine). And we know it was for a mine below Dudley Castle. But what did it look like? It no longer exists. Also there are no models of it either.
However David located a picture and made a model. He called it Newcomen's No 2 because David was sure that he must have made a prototype in Cornwall to know that the Dudley engine would work and sell the idea to Lord Dudley! He decided on 1/16th scale for the model.
It is clear that the model used masonry for the main structure so he had to make model bricks.
It did help that he was an engineer in the Doulton factory so was familiar with most of the skills and techniques and working with ceramics.
He had always been making things and had been given a lathe by his father when he was 17. This is the one he is still using. After completing this first model he went on to make another six models of the most significant early steam engine developments. This took him 45 years.
His brick machine uses spray dried clay and compresses it into bricks. These sintered bricks are then baked in a way that produces the wide variety of colours in old bricks.
On the models, all the valve gear linkage and mechanisms were lovingly hand forged to scale and to work correctly.
Was there anything you could improve upon he was asked? The questioner received a clear no. It was as accurate and exact as David could manage.
His research into these engines was helped by having a wife who was an industrial historian. There was a joke among his work colleagues that it was years before he took a holiday, he was always visiting industrial sites or other places for research.
This collection is in his house filling his front room. Every model is working, on a carriage, some on compressed air, the atmospheric engines on a vacuum and some by a discreet motor.
Well, we also had to view his workshop walking past some beautifully restored motor cycles to admire the equipment.
He showed us the smallest bolt he uses in the models which is 12BA (that is a nut threaded onto wire from a paperclip).
One of his demonstrations was using his lathe turning at 3,500 rpm turning down a

wire of about 1mm diameter. You certainly need a very sharp lathe tool exactly on centre for that.
Currently all the models are all in David's home and when a major extension at the Black Country Museum (just below Dudley castle) has been completed they will be set up there in the main entrance hall, although they will only run on special occasions.
David invites others to come and see his models. As he says he is always keen to talk about his engines (www.davidhulse.co.uk) There are several films of his engines on the website.
We had a very enjoyable and informative visit with a party of just the right size for this domestic sized setting.

NORTHERN IRELAND BRANCH

Visit to the agricultural engineering training facilities
CAFRE, Greenmount Campus, Antrim
22 March 2018
Report by Terence Chambers

The Spring meeting of the Northern Ireland Branch involved a visit to the training facilities within the Land Based Engineering Machinery and Building Centre (MBC) on the College of Agriculture, Food and Rural Enterprise's (CAFRE) Greenmount Campus, Antrim where members were welcomed by Programme Manager, Stephen Graham and his staff.
The MBC provides teaching of mechanisation / building skills, as part of the agriculture courses, and is also home for teaching of the 2 year City and Guilds Level 3 Technical Extended Diploma in Land Based Engineering.
This course provides the knowledge and technical skills required for a student going on to be a service technician in the landbased sector.
Successful completion of this Diploma is the foundation for going on to gain further experience in the trade and to gain Land based Technician Accreditation (LTA) status as a qualified technician.

Course content

As well as class room teaching of the theory around engines, electrics and hydraulics in tractors and farm machinery, the well equipped workshop areas in the MBC are used to develop practical servicing, repair and workshop skills. Electronic diagnostic equipment also now takes its place alongside the traditional specialist hand and power tools.

The required engineering skills cover the range of agricultural machines across the industry, so teaching is facilitated by direct in-house access to modern tractors, handlers, harvesters and other field machinery.
In addition to workshop repair and fabrication tasks, students also use and develop their skills and initiative by involvement in supervised business projects such as the refurbishment of used tractors or machines for resale to the open market.

Practical demonstration

As well as seeing around the machines and practical demonstration items within the workshop areas, the visitors took part in a practical discussion about the actual individual hydraulic components and controls for a compact GIANT artic-steer loader.
This moved to a detailed examination of the operational flow diagrams for the machine with examples of how the hydraulic flow is controlled for all of its operational functions including travel speed, change of direction, braking, steering and loader use.
This was followed with a practical demonstration watching several pressure gauges, added to the actual GIANT loader, to show how hydraulic pressure increased or decreased in the individual circuits. Examples included the action of the priority valve to ensure safe steering and the transmission disconnect function when the brake pedal was pressed in "brake to zero" mode.
The group then had an interactive discussion around the subjects discussed before expressing thanks to all the CAFRE staff for their time and efforts in making it such an enjoyable and informative evening.
More details of the Level 3 Land based Engineering qualification and other courses available from CAFRE may be viewed on www.cafre.ac.uk
The Northern Ireland Branch members were pleased to welcome IAgrE Chief Executive, Alastair Taylor, who joined them for the visit.
Plans are now being finalised for the 2018 – 2019 programme of technical meetings to start next October. As always, anyone interested will be welcome to attend and further details will be available by contacting Branch Secretary Ian Duff duffi@iagre.biz

MEMBERSHIP CHANGES

ADMISSIONS

MEMBER
Mr Danut C Andrei (East Midlands)
Mr P Mwebaze (Australia)
Professor S Pearson (East Midlands)
Mr H P Steenkamp (South Africa)

AFFILIATE MEMBER
Mr Peter MacCurrach-Paine (West Midlands)

TECHNICIAN
Mr S D Wilson (Scottish)

STUDENT
Harper Adams University
Magdalena Dolowy (Wrekin)
Przemyslan Dolowy (Wrekin)

University of Manchester
George Worrall (Yorkshire)

University of Glasgow
Allen Akwu-ude (Scottish)

Open University
Jordon Milner (Yorkshire)

Cranfield University
Ben Mcilwaine (S E Midlands)

York College
Thomas Hewitt (Yorkshire)

DEATHS
We have recently learned of the death of the following members and we send our condolences to their family and friends:

Mr DJ Welstead

TRANSFERS

Member
Mr D J Ingram
Mr D Job
Mr G C Pullen

Technician
Mr S J Scales

ENGINEERING COUNCIL REGISTRATIONS

EngTech
Mr H P Steenkamp (South Africa)
Mr S D Wilson (Scottish)
Mr S J Scales (East Midlands)

LONG SERVICE CERTIFICATES (1 July to 31 September 2018)

IAgrE extends warm congratulations to the following members on reaching significant milestones

Name		*Date of Anniversary*
60 years		
James Lowther McCumiskey	AIAgrE	10-Sep-18
John Charles Sartain	FIAgrE	16-Sep-18
50 Years		
Paul Adrian Crisford	MIAgrE	24-Jul-18
Eric Charles Fife Lacey	MIAgrE	25-Jul-18
Bryan William Maw	MIAgrE	25-Jul-18
David Thomas Wilkinson	MIAgrE	25-Jul-18

Name		*Date of Anniversary*
35 Years		
Suhayl Rawhani	MIAgrE	19-Jul-18
25 Years		
Niall James Pigott	AMIAgrE	12-Jul-18
John Livingstone Douglas	MIAgrE	18-Sep-18

ACADEMIC AND COMMERCIAL MEMBERS

ACADEMIC MEMBERS

Berkshire College of Agriculture
Hall Place
Burchetts Green
Maidenhead
Berks SL6 6QR

Bishop Burton College
York Road
Bishop Burton
Beverley HU17 8QG

Brooksby Melton College
Asfordby Road
Melton Mowbray
Leics LE13 0HJ

Coleg sir Gar
Gelli Aur Campus
Llandeilo
Carmarthenshire SA32 8NJ

Cranfield University
Cranfield
Bedfordshire MK43 0AL

Duchy College
Stoke Climsland
Callington
Cornwall
PL17 8PB

Easton & Otley College
Easton
Norwich
Norfolk, NR9 5DX

Greenmount College
CAFRE
22 Greenmount Road
Antrim,
Northern Ireland BT41 4PU

Harper Adams University
Newport
Shropshire TF10 8NB

Institute of Technology
Tralee Clash, Tralee
Co Kerry, Ireland

Lincoln Institute of Agri-Food Technology,
Lincoln University
Lincoln LN6 7TS

Manchester University
School of Electrical and Electronic Engineering
C39, Sackville Street Building
Sackville Street
Manchester M1 3WE

Myerscough College,
Bilsbarrow
Preston
Lancashire PR3 0RY

Newcastle University
King's Gate
Newcastle Upon Tyne NE1 7RU

Pallaskenry Agricultural College
Co Limerick
Ireland

Plumpton College
Ditchling Road
Lewes
East Sussex, BN7 3AE

Reaseheath College
Reaseheath,
Nantwich
Cheshire, CW5 6DF

Royal Agricultural University
Cirencester
Gloucester, GL7 6JS

Sparsholt College
Sparsholt,
Winchester SO21 2NF

SRUC – Auchincruive
Auchincruive Estate
Ayr, KA6 5HW

Wiltshire College Lackham
Lacock
Chippenham
Wiltshire SN15 2NY

COMMERCIAL MEMBERS

Agricultural Engineers Association (AEA)
Samuelson House
62 Forder Way, Hampton
Peterborough PE7 8JB

AGCO Ltd
Stoneleigh, Abbey Park
Kenilworth, Warwickshire CV8 2TQ

Alvan Blanch Development Co
Chelworth, Malmesbury
Wiltshire SN16 9SG

Autoguide Equipment Ltd
Stockley Road
Hedington, Calne, Wiltshire
SN11 0PS

BAGMA
225 Bristol Road
Birmingham B5 7UB

Briggs Irrigation
Boyle Road
Corby, Northants NN17 5XU

City and Guilds
1 Giltsput Street, London EC1A 9DD

City Farm Systems Ltd
25 Hepplewhite Close
High Wycombe
Bucks HP13 6BZ

David Ritchie (Implements) Ltd
Carseview Road, Suttieside
Forfar, Angus DD8 3EE

Douglas Bomford Trust
The Bullock Building
University Way, Cranfield
Bedford MK34 0GH

DSL Systems
Adbolton Hall
Adbolton Lane, West Bridgford
Nottingham NG2 5AS

FEC Services
Stoneleigh Park
Kenilworth, Warwickshire CV8 2LS

Fullwood
Grange Road, Ellesmere
Cheshire SY12 9DF

Household Sprayers
Roughton Moor
Woodhall Spa, Lincs LN10 6YQ

HSS Hire
25 Willow Lane, Mitcham
London CR4 4TS

JCB
Rocester, Staffs ST14 5JR

John Deere Ltd
Harby Road, Langar
Nottinghamshire NG13 9HT

Marks & Clerk LLP
90 Long Acre, London WC2E 9RA

Mastenbroek Ltd
83 Swineshead Road
Boston, Lincs PE21 7JG

National Fluid Power Centre
Carlton Road
Worksop, Notts S81 7HP

Reesink Turfcare UK
1-3 Station Road
St Neots, Huntingdon PE19 1QH

Shelbourne Reynolds
Sheperds Grove Ind Estate
Stanton, Bury St Edmunds
Suffolk IP31 2AR

SSAB Swedish Steel Ltd
Narrowboat Way
Hurst Business Park
Brierley Hill
West Midlands DY5 1UF

Teagle Ltd
Blackwater
Truro, Cornwall TR4 8HQ

TeeJet London Ltd
Headley House
Headley Road, Hindhead
Surrey GU26 6UK

Witham Oil and Paint Ltd
Outer Circle Road
Lincoln LN10 6YQ

FORTHCOMING EVENTS

IAgrE EVENTS

Thursday 18 October 2018
IAgrE Council Meeting
Harper Adams University

Tuesday 6 November 2018
IAgrE Conference
Engineering Collaboration for Success: Best practice for knowledge exchange in agricultural engineering.

The Royal Academy of Engineering, 3 Carlton House Terrace, London SW1Y 5DG

All enquiries regarding IAgrE Events, contact Sarah McLeod
Tel: 01234 750876
secretary@iagre.org

BRANCH EVENTS 2018-19

EAST MIDLANDS BRANCH
Contact: Richard Trevarthen
01509 215109
richard.trevarthen@gmail.com

Tuesday 9 October 2018
7pm for 7.30pm
Visit to the Burgess Group, Sutterton, Boston

Tuesday 13 November 2018

7pm for 7.30pm
Technical Talk: Prof Christopher Dungey from the Welding Institution
Quorn Lodge Hotel, 46 Asfordby Road, Melton Mowbray LE13 0HR

Tuesday 11 December 2018
7pm for 7.30pm
Technical Talk: Kirk Walker, MITAS UK
Quorn Lodge Hotel, 46 Asfordby Road, Melton Mowbray LE13 0HR

Tuesday 15 January 2019
7pm for 7.30pm
Visit to N J Froment & Co Ltd
N J Froment & Co Ltd, Easton on the Hill, Stamford PE9 3 NP

Tuesday 12 February 2019
7pm for 7.30pm
Technical Talk: Kit Franklin, Hands Free Hectare
Quorn Lodge Hotel, 46 Asfordby Road, Melton Mowbray LE13 0HR

Tuesday 12 March 2019
Visit: Belvoir Brewery
7pm for 7.30pm
The visit includes a tour of the Brewery, followed by a buffet supper, Belvoir Brewery, Station Rd, Old Dalby, Melton Mowbray LE14 3NQ

Tuesday 9 April 2019
7pm for 7.30pm
East Midlands Branch Annual Dinner & AGM The AGM will be followed by a two course Dinner, Quorn Lodge Hotel, 46 Asfordby Road, Melton Mowbray LE13 0HR

NORTHERN IRELAND BRANCH
Contact: Ian Duff 028 8673 6977
duffi@iagre.biz

Wednesday 17 October 2018
"Plant Hire - How and Why it Works", Speaker: Keith McIvor, Managing Director of KDM **Venue: TBC**

Thursday 31 January 2019
"The Electric Race - why it's so hard to make an electric vehicle battery":
Talk by Jaguar Land Rover
CAFRE, Greenmount

Wednesday 20 February 2019
Silage Science: Speaker Dr Conrad Ferris AFBI, Hillsborough

SOUTH EAST MIDLANDS BRANCH
Contact: John Stafford 01525 402229
john.stafford@silsoe-solutions.co.uk

Monday 8 October 2018 7.30pm
Technical Talk - 'Kubota's Vision' ...Customer First!
Speakers: Keith Miller & Mike Bywater Kubota
Maulden Church Hall, Church Road, Maulden MK45 2AU

Tuesday 13 November 2018 7.30pm
"Soil life: soil improvement service"
Speaker: Mike Slater, Frontier Agriculture plc
Meeting Room, The George Inn, George Street, Maulden MK45 2DF

Tuesday 11 December 2018 7.30pm
Technical Talk - Smart Machines:
Speaker: Deep Mukherjee, Bosch Rexroth
Meeting Room, The George Inn, George Street, Maulden MK45 2DF

Monday 7 January 2019 7.30pm
Technical Talk - "Advanced vehicle technologies in agricultural engineering"
Speaker: James Brighton, Cranfield University Cranfield University (TBC)

Monday 4 February 2019 7.00pm
AGM & Student Presentations
Maulden Church Hall, Church Road, Maulden MK45 2AU

Tuesday 12 March 2019 7.30pm
Technical Talk - "The application of drones in agriculture"
Speaker: Ben Smith, Hummingbird Technology Meeting Room, The George Inn, George Street, Maulden MK45 2DF

WESTERN BRANCH
Contact: Mike Whiting 07751 345580
mike.whiting@newmac.org

Wednesday 3 October 2018
Malt Sampling in Marlborough 11.00am
Ramsbury Brewing & Distilling Company Ltd, Stockclose Farm,
Aldbourne, Marlborough, Wiltshire SN8 2NN

Wednesday 21 November 2018
Visit to Mzuri Ltd Mzuri Ltd, Springfield Farm, Peopleton, Pershore WR10 2BF

Wednesday 23 January 2019
Film Night: "Blockbuster evening with Jim Wilkie"
The Greyhound Pub, High St, Bromham, Chippenham SN15 2HA

Wednesday 20 February 2019
Visit - German U-Boat Display - TBC
Venue and Time TBC

Wednesday 13 March 2019 7.00pm
AGM & Talk - "Hands free harvesting journey, concept to evolution"
Royal Agricultural University, Cirencester

WEST MIDLANDS BRANCH
Contact: Ian Moore westmids@iagre.biz

Tuesday 13 November 2018 7.30pm
Engineering Excellence, 50 Years of the Land Rover:
Speaker: John Holland Jaguar Land Rover Venue TBC

Wednesday 21 November 2018
Visit - Mzuri Drills
Combined visit with Western Branch
Mzuri Ltd, Peopleton, near Pershore

Tuesday 9 April 2019 7.30pm
AGM 2019
Friends Meeting House, Stratford on Avon

WREKIN BRANCH
Contact David Clare 01952 815097
dclare@harper-adams.ac.uk

Tuesday 18 September 2018
Workshop: Progressing IAgrE Membership Venue: TBC

Wednesday 10 October 2018 2.00pm
Visit: Innogy Wind Turbine
Rhyl Flat Windfarm, Port of Mostyn, Holywell

Tuesday 13 November 2018 7.30pm
Technical Meeting: Datatag security systems AEIC, Harper Adams University

Tuesday 11 December 2018 7.30pm
Technical Meeting: TBC
AEIC, Harper Adams University

Tuesday 15 January 2019 7.30pm
Technical Meeting: TBC
AEIC, Harper Adams University

Tuesday 12 February 2019 7.30pm
Technical Meeting: TBC
AEIC, Harper Adams University

Tuesday 19 March 2019
AGM and Technical Meeting 6.30pm
AEIC, Harper Adams University

Tuesday 30 April 2019 7.30pm
Technical Meeting: TBC
AEIC, Harper Adams University

INDUSTRY EVENTS

Wednesday 26 September 2018
Tillage-Live 2018
Dunbar, East Lothian

Wednesday 3 – Thursday 4 October 2018
Introduction to Soil Classification
Shuttleworth College, Old Warden Park, Biggleswade SG18 9DX

Tuesday 16 – Wednesday 17 October 2018 ***World Agri-Tech Summit 2018***
The Tower Hotel: Guoman St Katharine's Way London E1W 1LD

Tuesday 16 October 2018
LEAF Education and Public Engagement Conference
Rothamsted Research, West Common, Harpenden, Hertfordshire AL5 2JQ

Wednesday 31 October – Thursday 1 October 2018 ***SALTEX 2018*** NEC, Birmingham

Wednesday 7 – Thursday 8 November 2018 ***Farm Business Innovation 2018***
NEC Birmingham

Thursday 15 November 2018
Ag Careers Live 10am – 3pm
Villa Park, Birmingham

Wednesday 21 – Thursday 22 November 2018
Midlands Machinery Show
Newark Showground, Lincoln Road, Winthorpe, Newark, NG24 2NY

Wednesday 21 November 2018
AgriScot 2018
Royal Highland Centre, Ingliston, Edinburgh EH28 8NB

Wednesday 21 – Thursday 22 November 2018
Agricultural Land Classification Course
Arden Hotel, Coventry Road, Bickenhill, Solihull B92 0EH

Wednesday 2 – Friday 4 January 2019
Oxford Farming Conference
Oxford University

Tuesday 8 – Wednesday 9 January 2019
LAMMA 2019
National Exhibition Centre, Birmingham

24/7 Out of Hours

Our feature looking at the hobbies and pastimes of IAgrE members when not engaged in their day-jobs. CHRIS BIDDLE reports

CLIVE PINNOCK

Clive Pinnock EngTech AMIAgrE spent over 30 years with the UK distributor of Toro turfcare equipment and set up the company's in-house technical training centre at St Neots before taking retirement last May

Clive Pinnock decided at 65 that he didn't want to retire, but then neither did he want to keep up a punishing schedule of travelling, overseeing the technical training needs of dealers and customers of Toro Turfcare Products in the UK and across Europe.

He had been with the UK distributor of Toro (now Reesink) Turfcare based in St Neots for 34 years, so the company helped him establish an in-house training centre. He became the first in the turfcare sector to achieve Level 4 in the Landbased Technician Accreditation scheme (LTA), and established the facility as an assessment training centre in 2016.

In May this year, Clive finally took full retirement. A colleague said "Clive's product knowledge has been incredible, ask him about a machine made in the 1990's and he'll list all the features, modifications and upgrades off the top of his head!"

Today, freed from pressures of running the training school, Clive is able to spend more time on his lifetime hobby of racing pigeons, which he first became interested in at the age of 12.

He is currently chairman of the Huntingdon and District Racing Pigeon Club, breeds the birds and has a loft of about 60 birds which compete in races on most weekends during the racing season from April to September.

Most races involve transporting by lorry (the convoyers) a collection of anything between 1000 to 2000 birds to a UK location on a Friday, before release (the liberation) on Saturday when they trigger a tag and are timed to the point when they cross a timing pad in the owners loft. Clive's club usually fly south to north, a regularly

used release point is in the Salisbury area.

ROYAL PATRONAGE

The earliest recorded reference to the use of messenger pigeons comes from Ramses III (c1200 BC) when they were used to convey news between cities regarding the flood state of the Nile.

The Romans used pigeons to convey messages throughout the empire, for example Olympic games results for betting syndicates, and ships warning their home port of their imminent arrival.

In the 1800's there was an official pigeon postal service throughout France, and this was expanded between capitals so that a postal service by carrier pigeon between London and Paris was advertised in 1870.

The first regular race in Great Britain was in 1881. The Royal Family first became involved with pigeon racing in 1886 when the King of Belgium gave them breeding stock and the Royal tradition continues to this day. The Queen maintains a loft at Sandringham, and one of her pigeons won a race in the 1990's.

Pigeon racing has been described as a "sport with a single starting gate and a thousand finish lines" - competing birds are taken from their lofts and must race home. The time taken and distance are recorded - and the fastest bird is declared the winner. Races in the UK are generally between 60-100 miles but the season usually involves much longer races, with a race starting in Barcelona, one of the highlights of the season.

Flying in a straight line in still conditions, the birds can average about 45mph so only take a few hours to reach Clive's loft.

The life of a racing pigeon can be anything from 6 months upwards to the age of 6 to 8 years old.

On the open market in the UK, racing pigeons can sell for anything from £60 - £300 each. However, the sport is attracting new money. Earlier, this year, wealthy Chinese buyers paid in excess of £360,000 for pedigree racing pigeons.

Even so, the sport is rarely risk free. The hot weather during the summer of 2018 caused several races to be cancelled, and attacks on racing birds are all too common. "The biggest danger is from hawks and peregrines" says Clive "and birds can arrive back in the loft quite badly injured".

The national body, The Royal Pigeon Racing Association (RPRA) provides competitors with regularly updated information and location of reported attacks on birds "which are becoming more and more of a problem" says Clive.

"Pigeon racing is a wonderful hobby" says Clive, "but there is now quite a lot of money coming into what used to be a back-yard sport. Even so it can get quite expensive for the small pigeon fanciers what with the cost of corn, grit, tagging, tracking devices, vaccinations and transport".

Clive Pinnock has been involved in the technological advances of precision mowing equipment throughout his career, and now that new technology with GPS tracking and the like comes into pigeon racing, he is having to adapt to the new ways in this sport full of tradition.

Institution of Agricultural Engineers

Landwards Conference 2018

ENGINEERING COLLABORATION FOR SUCCESS:

BEST PRACTICE FOR KNOWLEDGE EXCHANGE IN AGRICULTURAL ENGINEERING

Tuesday 6 November 2018

Royal Academy of Engineering,
Prince Philip House,
3 Carlton House Terrace,
London SW1Y 5DG

Collaboration! In the United Kingdom there are superb examples of industry and university collaborations which lead to ground breaking technologies and revolutionary new practices. As Agricultural Engineering, already recognised as a key discipline enabling agriculture to deliver food security, grows and evolves to become even more critical to the modern industrial strategy, the need for better knowledge exchange has never been more important. How can collaboration in engineering work? What does success look like? What can go wrong and how can we avoid the pitfalls?

This conference will explore successful collaborations in engineering between commercial, industrial, research and academic partners. Senior engineers with experience of successful knowledge exchange will share their expertise. Those businesses implementing new technologies will identify the barriers which need to be overcome if industry and research knowledge transfer can be translated into new practices and truly impact on the end user.

This conference is for everyone interested in bringing new technologies and innovative know-how into the agricultural supply chain, including engineers, scientists and technologists, farmers, growers, producers, and policy makers.

Key benefits of attending

- Gain an oversight of technological developments emerging in modern agricultural engineering and AgriTech
- Focus on the challenges of knowledge exchange and industry/ university partnerships
- Learn about cutting edge insights into knowledge exchange best practices
- Find out what you need to consider if you are to engage in successful collaboration
- Participate in elevator pitches where you might contribute expertise or gain support
- Meet like-minded people and forge future collaborative relationships
- Develop ideas and initiate new approaches alongside industry leaders

Conference speakers


PROF JANE RICKSON


DR SUSANNAH BOLTON


KEITH NORMAN


PROF KEITH RIDGEWAY

When, where, how much, where to book?
When: Tuesday 6 November 2018
Where: Royal Academy of Engineering, London
Cost: Member Delegate Rate £100 + vat,
Member Retired Rate £75 + vat,
Student Member Rate £40 + vat,
Non-Member Delegate Rate £150 + vat,
Non Member Retired Rate £100 + vat
Booking: www.iagre.org/IAgREConference2018