David Dowler

23 February 1930 – 19 January 2003

A history

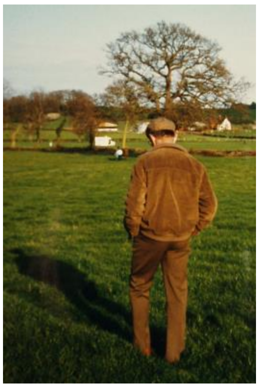
Compiled initially from notes taken at a meeting on 20 March 2004 with Julia Dowler (David's widow) and Dave Wilkins.

Augmented subsequently from reports and information gleaned from a wide range of sources.

Gantry concept emerges

David was introduced to farming at a young age when his family bought a farm in the Cotswolds. At 25, he took a two-year course (completed in one year) in General Agriculture at what is now Harper Adams University. He returned to the family farm to take over the arable enterprise, which under his management was often the first to adopt new technologies.

The first inklings of David's new passion were in the form of a Meccano model. This was something that David had been mulling over for many a month, typified by his standing in the yard or in the field, head down and oblivious to all around him.



Dave with his newly acquired skills was asked to weld this up as a full size forty-foot wide machine – the first gantry to grace the fields of Stamford Hall!

"P1" as it was known, was prompted by aphids! The summer of 1976 saw them arrive in their millions and David was appalled at having to flatten around 20% of the cropped area simply to apply the necessary sprays for their control. He also recognised the damage that machinery compaction was doing to the soil, and through logical thought and with no knowledge of previous attempts at such a design, came up with the idea of a wide-spanning machine. A Hesston swather was purchased and this, with its 66 hp engine, hydrostatic drive, castor and drive wheels formed the main power train for the vehicle. Workshop equipment consisted of an Oxford welder, a power hacksaw and bench drill. P1 was built outside on trestles and was designed "on the hoof" and without drawings, other than the odd sketch presented to Dave for clarity. With some thought for the second hand value of the Hesston machine should the project fail, it underwent minimum modification and was mounted on top of what was a square section space frame (Fig. 1).

On the other hand, an already well-used Nodet fertilizer spreader was considerably modified to position it as close as possible to the centre line of the frame. This was to avoid excessive overhang and torsion. A spray tank was built into the outer end of the machine with the engine and driver positioned at the other. (Fig. 4)

Fig. 1. The first prototype gantry (P1) showing minimum modification of the Hesston swather power unit that was mounted on top of the frame.

This arrangement demonstrated the considerable thought that David had already put into the project. Conventional logic would have placed the driver in the middle of the span, but this fundamental mistake was avoided. P1 rolled out of a newly built barn in January 1978. Field trials soon identified a problem that David had missed – one or other of the castor wheels would often leave the ground – proof that a truly rigid frame had been built, but also of the fact that across a forty foot (12 m) span, very few fields are level! A hasty visit to a local car breaker's and the necessary suspension and damper system from an old Ford car was soon secured and fitted.

This machine was used successfully on the farm for the next 5 years and the Hesston components were more fully integrated into the chassis. It operated alongside a straw burn and minimum tillage regime, with a crawler tractor whose tracks were fitted with wooden cleats (Fig. 2).

Fig. 2. The Massey Ferguson 174C tracked tractor fitted with wooden cleats. This tractor was used for shallow tillage and drilling across the whole farm

A Massey Ferguson harvester on rice tracks made up the machinery complement. David demonstrated the low pressure of the tracks on the ground by driving the machine over a row of metal drums. Despite the very significant weight of the harvester, all the drums remained intact (Fig. 3).

Improved designs

Following harvest in 1983, David was ready to move on to P2 – a machine that provided a significant step forward in design and the range of tasks that it could perform. The square box frame was replaced by a triangular design that allowed the Nodet fertilizer spreader to form a structural component. Equally, this could be removed and space frame members bolted in to take its place. The space frame design was based on the Bailey bridge principle, with which no doubt David had become thoroughly familiar in his hours of reading. He was fortunate in having a "photographic memory" for all things engineering. Of tremendous importance to David was keeping the weight of the vehicle to a minimum – an area of constant battle once it came to production versions and over which he was never able to maintain complete control. P2 however was a triumph. It only weighed around $3\frac{3}{4}$ t and was capable of 12 m full width fertilizer application, 24 m spraying and 12 m cultivation and drilling (Figs 4 & 5). The successful operation of the machine and the considerable interest shown in it made the team proud of what they had achieved. Many spring and summer evenings were marked by visits from local farmers. Dave recounts that David was a good person to work with, not "for", he was always made to feel very much part of a team; he had an amazing amount of energy, never had a cross word and was patience personified.

Fig. 3. The harvester on rice tracks demonstrating just how low the ground pressure was beneath them

Fig. 4. The second prototype machine (P2). The Nodet fertilizer spreader formed part of the lightweight spanning frame. Upon removal, space frame members were bolted in its place.

Fig. 5. The driving position of P2 showing the four cylinder Deutz air cooled engine (left) and the mirrored driving positions (right).

Commercialisation

In the meantime, B&W Mechanical Handling at Ely was making a first attempt at commercialisation based on P1, the initial square-section space frame design. They formed a subsidiary company called "Countridge", which in 1983, without a great deal of interaction with David, started building the "Monotrail". This had a rotating cab in place of the simple two seating position arrangement that David had devised and many other features, most of which added weight rather than function. The outcome was a much heavier machine that although looking reasonable (Fig. 6) was still equipped with the original Hesston transmission based on high-speed low torque motors. With these it was often incapable of driving itself across the field, let alone carrying out any useful work! This was not a commercial success and when the company went into liquidation, the few machines made were sold off. One of these went to Urbana, Illinois as a research tool while the remaining two (one of which was incomplete) went to the National Institute of Agricultural Engineering (NIAE) to form the basis of their wide span research and development programme.

Fig. 6. The Countridge "Monotrail" with the addition of a three-point linkage and cultivator frames after it had been purchased for research by the NIAE at Silsoe, UK

A second attempt at commercialisation was made in 1988, again based on P1 rather than P2. Mel Burrell Fabrications were commissioned to construct the machine and the first attempt resulted in P3 with a square-section space frame that looked much better, but was again plagued by being overweight at around $5\frac{3}{4}$ t unladen (Fig. 7).

Fig. 7. The second attempt at commercialisation was a machine built by Mel Burrell Fabrications Ltd. The design was based on P1 and although introducing many new features such as centre section height adjustment, it proved too heavy for the power available.

The transmission oil pressure had to be increased and as a result additional cooling was needed. Critically, it also had major problems with the electro hydraulic steering system and it was at this time that Dave Thomson of T.E.C. Technology Ltd was contacted. This was to be a fruitful and mutually beneficial relationship. Coincidentally, it was around this time that David was introduced to Lawrie Watts by Tony Turner (of Turner International Ltd). Tony had done some fabrication work for David and thought that Lawrie and David would have much in common. Lawrie's background was as a design engineer for Armstrong Whitworth and then as a technical illustrator for ILIFF Press. Here again, this was to be a close and fruitful relationship.

T.E.C., which specialized in electronic/electro-hydraulic control systems and "fly by wire" steering on boats, had only recently been set up by Dave Thomson and was recommended to David by A & D Fluid Power Ltd who had been supplying him with hydraulic control valves for the gantry. The subsequent growth of T.E.C. was in no small part due to its involvement with David's gantry project. News of a successful gantry control system spread quickly and led directly to a large rail contract and to T.E.C. becoming a significant supplier to major European agricultural manufacturers, which continues to this day.

With Dave Thomson and Lawrie working on the problems of steering control and excessive weight, P4 was born. The frame was a hexagon of 350 mm side length made up from two pressed 3 mm thick steel sheets bolted together. This not only gave a sleeker look to the machine, it also enabled implement hitches to be positioned more flexibly across the span using a clamping arrangement (Fig. 8). The tube contained all pipes and wires and joined, via monocoque end units and height adjusting slides, the engine and spray tank pods. The new frame, because of its length had to be pressed out by a shipbuilding company, but GKN Sankey confirmed its strength

Fig. 8. The two-part hexagon frame showing how the sheets were bolted together and the implement hitch clamped

by verifying that it could support 8 t at its centre. P4 was road tested at 17 mile/h and was used to sow 12 acres of winter wheat on 12th October 1989.

Dowler Gantry Systems Ltd

Further field trials with P4 were followed by the launch of P5 on 1st December 1988, a fully commercial machine under the banner of Dowler Gantry Systems Ltd (DGS Ltd) and illustrated by Lawrie Watts (Fig. 9). Setting up DGS was David's means of regaining control over the project. He had been persuaded in the mid 1980s that promotion of the idea was necessary to gain a market and a number of partners had been involved. It had not been successful and considerable resources had been used.

DGS Ltd sold the commercial machine (P5) to:

IMAG, a research institute at Wageningen in the Netherlands.

University of Brisbane, Gatton College, Queensland, Australia

Gleadthorpe Experimental Husbandry Farm, Nottinghamshire, UK

Silsoe Research Institute, Bedfordshire, UK

University of Hohenheim (This 6 m version of P5 was built by Toby Robbins at Alcester)

Tim Coulton, Farmer, Northamptonshire. Tim Coulton's machine was the one that had been demonstrated at the Royal Show. David was rather reluctant to sell this to Mr Coulton because he was concerned that he would want the machine to do more than its design allowed. Although this actually proved to be the case, Mr Coulton was very happy with its performance within its design specification.

IMAG used their machine in an extensive programme of research and this included work with sugar beet. Sowing of this crop demonstrated the enormous versatility of the gantry, it being capable of operating 24 units simultaneously (Fig. 10). Not only that, but these units could be transported simply by raising them within the width of the gantry frame and travelling lengthwise along the road without the need for folding.

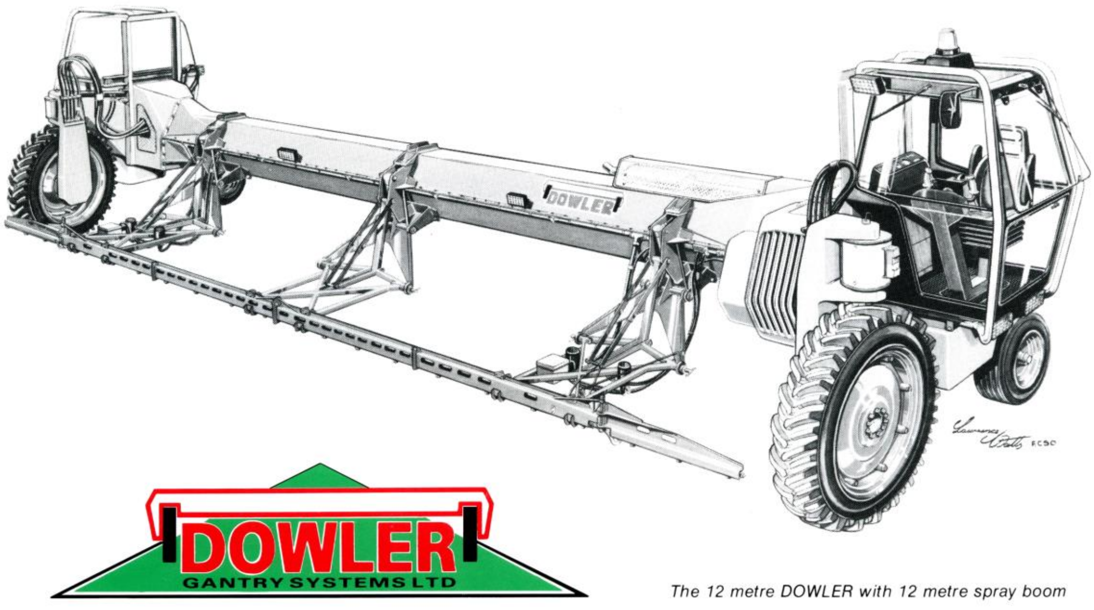


Fig. 9. Illustration of P5, the fully commercial version under the banner of Dowler Gantry Systems Ltd (Illustration by Lawrie Watts)

Fig 10. The Dowler P5 purchased by IMAG operating with a 24 unit sugar beet drill

P5 incorporated a number of innovations. It was equipped with the means of 12 m cultivation and sowing, 12 m solid fertilizer application and 24 m spraying. It had a 67 kW Perkins engine and delivered power to two wheels hydrostatically via electrically operated swash pumps and low-speed high torque wheel motors. Height beneath the main spanning beam was adjustable from 800 to 1500 mm using electro-hydraulic controls located on the end units, while height of the spray boom could be adjusted separately from the cab. Space within the cab was limited to some extent by the beam height adjustment pillars on the one side and the need to minimize overhang on the other (to avoid hedges and trees while driving around the field boundary).

Transport width of the vehicle was fixed at around 2.8 m (with 9.5 x 44 tyres). The three linkages on each side of the frame were designed to lift 0.5 t at their outer ends with implements being attached through a parallel linkage system. Cleverly these could accommodate two implements simultaneously. This was achieved by attaching one implement to the outer ends of the moving arms on one side and to the inner ends on the other. A second implement (for example a spray boom) could then be mounted on the remaining outer ends of the arms (Fig. 11). The inner and outer ends could be raised and lowered independently, (albeit with some interaction) using separate hydraulic controls. Each pair of linkages could also be controlled independently and one or other isolated manually. In addition, a float selection switch allowed the implements to follow ground contours or to maintain a fixed height. A 6 m version of the machine, specially designed for Hohenheim University in Germany, included a cross-slide three-point linkage with a 30 kW power take-off (Fig. 12). Toby Robbins, a master fabricator and welder, used drawings provided by Lawrie Watts to build this machine.

Fig. 11. The production version of the Dowler gantry (P5) showing the attachment of two implements simultaneously, namely spray booms and cultivators

The clever design and innovative ideas associated with these machines were widely recognised. David received the Robert Barrow award for innovation at the Royal Show in 1989. He was also thrilled that his machine was featured in the 12th edition of Culpin's "Farm Machinery" in 1992. A description of the machine and the role that it fulfilled within agriculture were accompanied by three illustrations. It also came to the attention of the news media and Independent Television News visited with a crew headed by Keith Hatfield in 1989. Fig. 13 shows David in typical form sharing a joke during filming. This film provided a lasting impression of the stability of the gantry when spraying. Cleverly the crew had arranged for the gantry to come into view over the brow of a hill where the 24 m boom was clearly outlined against the sky; it remained perfectly parallel to the ground, unlike most tractor-based systems.

Fig. 12. A 6 m version of P5 that was customised for the University of Hohenheim in Germany. It incorporated a 30 kW power take-off that could be moved laterally on the sub-frame rails.

Fig. 13. David sharing a joke with Keith Hatfield during a filming session with ITN in 1989

The chain of events during the period from the late 1980s is presently rather confused and Table 1 lists pieces of information (not particularly in chronological order), which show just how much interest was generated by David's innovative ideas. The list also provides a useful basis for more research and information. The fact that London's, "The Times" ran about 12 column inches plus a photograph reflects the fact that the gantry was seen to be of interest nationally, and to a wide audience. David was also well aware of the value of intellectual property. As will be noted from Table 1, his first patent application was filed on 28 February 1977 and published subsequently on 12 November 1980. David's patent application activities continue from that date until 11 July 2002, when together with Dave Thomson and Lawrie Watts a further amendment to the "vehicle" was published.

Despite difficulties with commercialisation and limited acceptance of the idea, David never had any doubts that the gantry was the right concept and machine for mechanised agriculture. This was emphasized when one field on the farm was ploughed after 20 years of using the low input gantry system. David regretted the day, but it did remind him of the reasons why he had moved away from intensive tillage in the first place.

David was also well ahead of his time when he recognised the crop damage associated with chemical applications to tall crops such as oilseed rape. Thirty years later and we now have self-propelled high clearance machines that are accepted as the norm.

Table 1. People, publicity and events surrounding development of the Dowler Gantry

Date (if known)	People/Organisations	Activity
28/02/1977	Withers & Rogers	Patent application filed for "Improvements in or relating to agricultural implements
12/11/1980	The Patent Office	Patent Specification published, no. 1 578 857
	Brian Eyers & Ian Rutherford	Advice and dissemination of information (ADAS)
4/10/89	Keith Hatfield	ITN film crew visited and took considerable footage
	Central Office of Information	Video made
	Peter McCann, BBC	Tomorrow's World
	Lawrie Watts	Lawrie did full working drawings for P4.
	Tony Turner	Built telescopic version of the machine that was displayed at the Royal Show
13/11/89	Withers and Rogers	Registered design No. 1 059 010. "A vehicle"
10/7/86	Big Farm Weekly	Article entitled: "Farmers fish for support on new ideas"
17/1/86	Farmers Weekly	Tractor supplement
21/3/86	Farmers Weekly	xx-xxi. "True zero-wheelings with first commercial gantry"
July/Aug 89	Farm Equipment International	
July 1989	Royal Show	Robert Barrow Award
July 1989	What's New in Farming, 12: 10	Report
August 1989	What's New in Farming, 12: 11	Report
Sept. 1989	What's New in Farming, 12: 12	Report
October	Power Farming	Report
1989	Big Farm Weekly	Report
22/6/89	Farm Contractor	Report
July 1989	Farmers Weekly	Cereals 89 Supplement. Article entitled: "Futuristic farm helpers".
9/6/89	Farmers Weekly	Report: "Field gantry brings savings"
15/9/89	Farming News	Report
9/6/89	The Times	"Environmentally friendly cultivator hailed as an advance. Farmer's invention may put paid to land spoiling tractor."
11/9/89	Farm Equipment International	Royal Show report
July/Aug	BSRAE Association News	Report
1989	Farmer's Guardian	Report
July 1988	Farmers Weekly	Report
12/1/98	Farming News	Article about Conserva-Pak drill for direct seeding
19/1/90	The Patent Office	Patent number WO/1990/007866, "A vehicle"

Sadly, DGS Ltd went into liquidation in the early 1990s, proof that a good idea and product are not always enough to secure a sustainable market.

Continuing development

Such was David's enthusiasm for keeping the idea going that in close partnership with Lawrie Watts and Dave Thomson, he came up with improved designs for the gantry. These addressed the issues of stress on the king pin of the steered wheels and the need for high power wheel motors and considerable piping for the hydrostatic transmission. These ideas led to a new patent being applied for on 23/11/94 (UK no. 9423669, application no. 39862/95) and subsequent filing in the US (Patent no. 6029431, 29/2/00: Drive wheel steering) and European patent no. 0793411 on 5/6/02 (first published on 10/9/97 and entitled "Vehicle"). Essentially, the design incorporated the steering within the wheel using a standard type of king pin geometry (Fig. 14). This enabled almost the same degree of steer angle as the previous designs, but was extremely compact and eliminated the large load moment created by having the king pin above the wheel. The machine also had two engines and four wheel-drive. Although this sounds expensive, it made a lot of sense, particularly as control of the engines and steering would be in the capable hands of Dave Thomson of T.E.C. A design of this nature would allow much smaller wheel motors to be used (because each could only absorb the power from one engine), it cut out a lot of the pipe work and hydrostatic losses and it distributed loads more evenly. The spanning boom was also improved by making this out of 8-foot lengths that could be pressed into shape by a local engineering company. Bolted bulkheads transmitted the loads very efficiently and square section tubes at each corner were used for clamping the implement hitches. A revolving cab provided the driver with more space than had been possible with the swivelling seat arrangement. This also minimised the overhang in field mode and allowed the driver to be perfectly in line with the drive wheels.

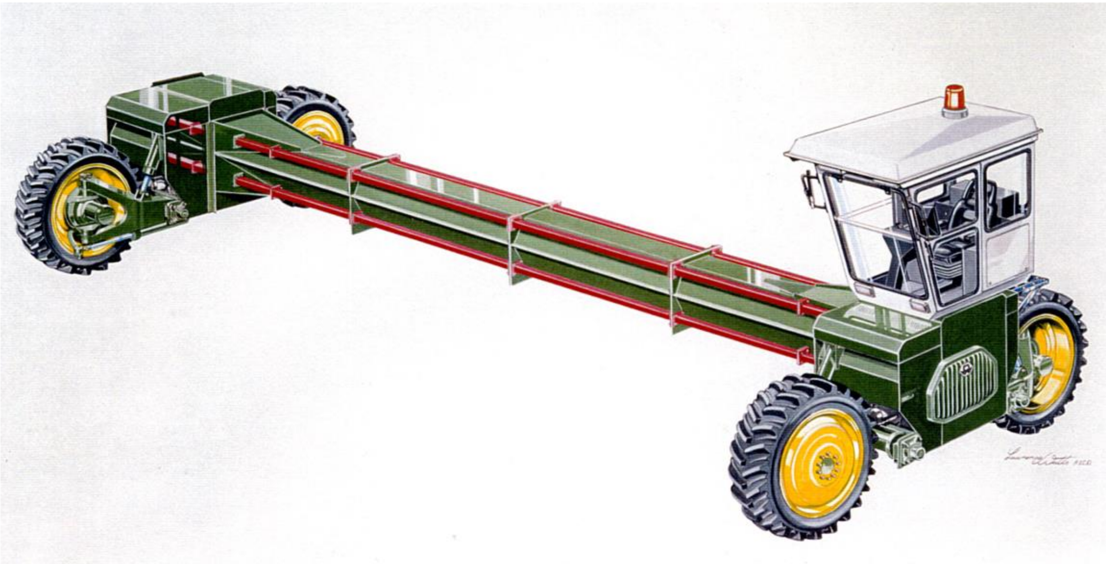


Fig. 14. Illustration of the two-engine design with the steering king pins incorporated within the wheel rims. This design also overcame the problem of long sheet steel pressings by introducing bulkheads. (Illustration by Lawrie Watts)

David also foresaw that eliminating compaction from the cropped area would promote direct drilling more widely. As a result he sought appropriate designs that would work effectively and reliably through a thick straw cover. This he achieved with the Conserva-Pak seed opener from Canada (bought out by John Deere in February 2007). He imported the seeder in kit form and single-handedly assembled the complete machine, which he then trialled successfully on his and on two other farms in the Cotswolds.

With the recent introduction and development of satellite guidance systems, some argue that the need for a gantry system has been circumvented by technology; in effect, that existing equipment used precisely can do the job. Ascribing to this view generally reflects a lack of understanding of the attributes of a gantry with which David was so familiar. Primary amongst these is the fact that a gantry system automatically and very precisely marks out its own operating grid within a field. Although satellite guidance systems now make this possible with tractors, any failure of the system leads to cessation of accurate matching, whereas with a gantry it does not. A further factor is that any wheel running on a moist soil inflicts damage and you can't have 10 m wide equipment supported totally on a tractor without outrigger wheels. Wheels mounted within a cultivator or drill increase the energy needed to work the soil, whether it is during or after the event. Wide equipment of this nature also requires enormous strength (and thus weight) within itself to support and pull from a central point. With a gantry, implements are divided into small and lightweight units whose depth of operation can be controlled by contact-less devices or lightweight gauge wheels that provide no direct support to the implement. It is also the case that although we now have sophisticated levelling systems for spray booms, there are very few that can maintain a constant height above the ground. Viewing the perfect stability of a 24 m spray boom mounted on the gantry when the whole rig was approaching over a rise at around 15 km/h leaves a lasting impression! There are many other facets of the gantry system that have the potential to improve the efficiency of crop production and in very diverse ways. Amongst these is minimisation of the area "wheeled" per unit width. Best practice for a tractor-based controlled traffic system in the body of a field might reduce the wheeled area to around 11% whereas a 10 m track gantry can achieve less than 6%. If one includes the headland area, the gantry's advantage is increased still further (Chamen et al., 1994). The aerial photo taken at Stamford Hall Farm in the 1980s illustrates this advantage clearly (Fig. 15).

Fig. 15. Aerial view of gantry wheelways (12 m spacing) at Stamford Hall Farm in Warwickshire, England

Economics

As we have seen, David was initially prompted to design a gantry because he wanted to avoid crop damage whilst spraying aphids, but he was also well aware of the potential that a machine of this nature had to avoid soil damage. This he could see would allow him to significantly reduce his tillage inputs and in particular to avoid ploughing. It was therefore in the late 1970s, when straw burning was allowed and with P1 carrying out all chemical applications, that David was able to use in perpetuity just a light tracked tractor (Fig. 2) for shallow tillage and drilling. Harvesting was with the harvester fitted with rice tracks (Fig. 3).

David also found that he no longer needed to subsoil on his farm, something that he would have done on a regular basis in the past. His costs therefore would have been amongst the lowest compared with traditional techniques and as evidenced from photos of the farm, weeds and crop variability were not an issue (Figs 11 & 15). Using research by Patterson et al. at about this time (1980) suggests that David's costs would have been around £20/ha compared with £32/ha for ploughing and £23.50/ha for chisel ploughing, the latter not including subsoiling that would almost certainly have been necessary from time to time. David's system would also have allowed him to cover the whole area of his farm single handed without compromising timeliness of sowing.

In 1999, as part of the commercialisation process and in conjunction with Ingemar Bjurenvall, David conceived a new name for the gantry, the "Biotrac". It was proposed that it would form part of a highly efficient, environmentally friendly "branded" industrial farming operation. Biotrac "brand" would deliver "Top Whole Crop" using a 6 m wide cereal crop "stripping" system. The stripped grain together with the light fraction (chaff, flag leaf and some straw) would be baled, wrapped and chemically treated and have a value of £80/t. The remaining stem straw was predicted to have a value of £30/t. On a projected area of 1200 ha (3000 acres), an annual gross margin of £M1.08 was calculated with a machinery rental cost of £160,000 per annum. This system was considered to have a number of advantages in addition to its low operating costs. It would for example leave most of the straw in the field standing because no wheels would run over it during the stripping process. This straw could be left for a significant period without the fear of deterioration, particularly if it were to be used as fuel. Equally, with the high precision methods available through the gantry system, it would be possible to sow a new crop between the rows of standing straw. Such an environment would deter pests such as pigeons and slugs, the latter having no residue on the surface under which they could hide.

Stripping the crop and using the light fraction also has the advantage that it removes a proportion of the weed seeds that are returned to the field with a conventional harvester.

David's legacy

David's prime legacy is that you can travel the world and mention the word "gantry" to an agricultural audience and almost invariably they respond with; "wasn't there a farmer in the UK that put a system like that together?" Many also remember his name. This is proof that an individual with belief and determination can make a global impact and with very limited resources. It is also true to say that he brought practicality and ease of use to the gantry concept. Any reasonably competent driver would have the machine spinning around the field and generally under their command within 15 minutes of getting in the cab. This was no mean feat when the controls more closely resembled those of an aircraft than a tractor (Fig. 16)!

Fig. 16. The steering control column in P5 with ancillary hydraulic controls and services

David's belief that the gantry was a more efficient mechanisation system for crop production than the present-day tractor never dwindled and his enthusiasm for it was never dampened. His enlightenment and his legacy on these subjects will be judged by future generations but presently no one can doubt his lasting contribution to agriculture and his pioneering spirit.

He is deeply missed by all those who experienced the privilege of his company.

Tim Chamen

August 2007

Maulden, Bedfordshire

Tributes

Dave Thomson, T.E.C. Technology Ltd

I spent many happy hours in David's company, and he soon became a friend rather than a customer. I will always remember the times in the kitchen at Stamford Hall Farm, discussing aspects of the Gantry and enjoying the cakes and other delicacies prepared by Julia.

One memory is very prominent. I visited the Royal Show with my wife Marian, who is not known for her interest in things mechanical. David was at the show with one of the Gantries. Marian knew of the project, but had not seen the machines before, and was introduced to David for the first time. On leaving she said "*what a brilliant machine, and David is such a gentleman, I do hope he succeeds*".

I feel that I was very privileged to have known and worked with David, he is deeply missed. David was a real gentleman, kind, trusting and generous - it is a pity that the same cannot be said of some of those who associated themselves with his project.

It is sad that he did not live to see the full potential of his brainchild realized, but I am certain that in the not too distant future his enlightenment, enthusiasm, determination, and hard work will prevail for the benefit of all, over vested interests.

References

Chamen, W.C.T., Dowler, D., Leede, P.R. and Longstaff, D.J. 1994. Design, operation and performance of a gantry system: experience in arable cropping. *Journal of Agricultural Engineering Research*, 59: 45–60.

Culpin, C. 1992. Farm Machinery, 12th Edition. pp. 61–62. Blackwell Scientific Publications Ltd. ISBN 0-632-03159-X.

Patterson, D.E., Chamen, W.C.T and Richardson, C.D. 1980. Long-term experiments with tillage systems to improve the economy of cultivations for cereals. *Journal of Agricultural Engineering Research*, 25: 1–35.

Tyler, R.S. 1990. Is the gantry a viable proposition for farmers in the UK? Cranfield University, Silsoe, (MSc thesis).