Chapter 2
The Wrest Park years 1948–2006

The Institute's move to Wrest Park in Bedfordshire was completed in 1948, and this was to be its home for 58 years. During those years there was a gradual though deliberate shift from machinery research, development and testing for agriculture to a wider base of physical science and engineering research for biological systems. Throughout, much of the work was taken up by the agricultural industry – benefiting farmers and agricultural engineering companies; in the later stages, some of the research was also taken up in the food and environmental sectors, and even began to find application relating to healthcare. As with many organisations depending predominantly on government funding, a steady stream of changes in government and departmental policies, budget constraints, novel funding mechanisms and the political footballs of the day buffeted and shaped the Institute.

Reconciling the demands of science and the magnificent setting of Wrest Park, with its historic grounds and Grade I listed Mansion, was always a challenge, from the early days of Nissen huts and growing potatoes in the Gardens to the final phase of new laboratories, estate reviews and questions over future sustainability. Everyone who worked there can tell a story or two about the Gardens, the games or the ghost. The Gardens were (and are) the responsibility of English Heritage and open to the public at certain times, but Institute staff maintained them (Fig. 2.1). Most people took advantage of the spacious surroundings – the croquet lawn, cricket field, hockey pitch, or the Long Canal, where skating was occasionally possible and Raft Races were a feature of many a summer staff garden party. Then there were the lunch-time strollers in the woods and the runners pounding around them, or up the track towards Gravenhurst. There were even occasions when the odd 'A' (or more likely 'B') list celebrity might be spotted when the Mansion was acting as Lady Hamilton's house in the story of Nelson, a European Commission haunt for Alexei Sayle in 'The Gravy Train' or as Buckingham Palace in a Japanese advert for Kit Kat! And those in the right place at the right time had the opportunity to encounter the Grey Lady – in the Mansion cellars or on the main staircase or …?

> *"I went down to begin work in the January of 1948 in the Agricultural Testing Department. … The big and formerly grand Wrest House was a mess … (and) the entrance hall was covered in mud.*
> *Eventually when the big new workshops were completed we moved over into the wooden huts which the builders had been using. Each group of huts had a wash hut containing showers, which were not used as we were not familiar with showers in those days … (and) also baths, basins and toilets. The walls of these huts were very thin so the water frequently froze."*
>
> **John Dunn**

This chapter provides an overview of the Institute's work, especially the external events and pressures that shaped change. Within the chapter, personal views from some Directors during this period are included to give individual insights into life at the Institute, and many of the research issues alluded to are dealt with in more detail in other chapters.

Figure 2.1 – Around 40 ha of formal and informal gardens at Wrest Park were maintained by Institute gardening staff.

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Most people remember the Institute as a unique organisation, committed to engineering insights and innovations for the agricultural sector and working closely with sister Institutes, university departments and the industry itself to deliver results. The summary of external influences that this chapter presents may suggest that the Institute ship was sailing stormy seas for much of the time, but throughout there was a strong common approach on board, linking basic scientific understanding through to application – and from the succeeding chapters a very positive story of successful activity emerges. The practical engineering mindset ensured that approaches were realistic and relevant. The science provided understanding of the materials, processes and systems involved, ultimately enabling more efficient or effective performance through the application of engineering. Frequently, the biological scientists at sister organisations were challenged to deliver a design specification for an engineer to optimise and control. For instance, full environmental response curves for glasshouse crops, so we could propose optimal environmental control; the optimal spray distribution on a plant for disease control, so we could devise how such a distribution could be delivered; the precise conditions needed around a seedling for successful emergence and establishment, so we could propose the soil properties and how to achieve them – all serve as examples of engineering challenges that the Institute tackled with vigour alongside other Research Institute colleagues.

The links with the industry, both engineers and farmers, were always firm. They often depended on enlightened individuals who understood the long term value of an established centre of expertise that could deliver the insights of new engineering science. The applied science that was at the heart of the Institute's programme throughout its life delivered real innovations and benefits to the UK economy as well as contributing new scientific understanding at a more basic level. The academic establishment might have considered the Institute as a poor relation at times, particularly when the national passion for research assessment by the most simplistic of mechanisms was at its peak – but when our university colleagues got to know our science we invariably gained their respect. The outcomes have proved of great value and our international reputation was always as one of the very best research centres for agricultural engineering in the world.

Establishment and consolidation at Wrest Park (1947–1961)

After the War, the premises at Askham Bryan were needed for their original purpose, the Yorkshire Institute of Agriculture, now Askham Bryan College. There were two decisions at this time influencing the future remit of the NIAE – one was to set up a Scottish Machinery Testing Station at Howden, Midlothian, and the other was to retain horticultural engineering with NIAE rather than set up a separate establishment. The site at Silsoe was selected for several reasons: a number of different soil types were available nearby; other agricultural research stations were easily accessible, especially Rothamsted Experimental Station; Bedfordshire had at that time both arable and livestock farms and many horticultural enterprises; and a major requirement for those with influence over the location was easy access to London, where the Ministry of Agriculture and Fisheries (MAF) was based, and many meetings were held.

It was the custom for formal published references to early Institute Directors to use their initials, so we have followed suit. S J Wright retired and W H Cashmore was appointed to replace him. He records that the move to Wrest Park took a year, with two or three trips per week for him between Yorkshire and Bedfordshire. He comments ruefully that being Director entailed serving on over 30 committees. He also became involved with agricultural engineering education at the Universities of Newcastle, Cambridge, London, Reading and University College, Dublin.

With the move to Wrest Park, the research emphasis at NIAE began to change in the direction of longer-term projects and less ad hoc work. However, the testing programme was as important as ever, because of the flood of new designs of tractors and implements: 'British manufacturers were quick to make good the lack of development during the war, and they welcomed the chance to have independent reports on experimental and prototype tests. For the first two years about 50 test reports a year were issued' said Cashmore in his memoir. Testing tractors and machinery was an ever-present feature of the Institute, from its beginnings in Oxford, on establishment in Wrest Park, and through to closure, but the approach and the mix of different types of testing activities varied, as this and later chapters will show.

Management changes

The visit by King George VI in 1949 confirmed the NIAE's established status within the agricultural research service (Fig. 2.2). In this year responsibility for the Institute was transferred from MAF to the Agricultural Research Council (ARC). The Council, established by Royal Charter in 1931, had already influenced the development of the Institute, having reviewed the Institute's engineering work in 1932 through an

Figure 2.2 – Visit by King George VI in 1948: with Lord Radnor (behind the tractor wheel), WH Cashmore to the King's right, and Wattie West on the far right.

Engineering Sub-Committee of the ARC Soils Committee (Chapter 1). The Research Council had responsibility for providing research support for UK agriculture, predominantly through its Institutes, some of which were owned by the Council, and some like NIAE receiving a grant-in-aid. The Council's interest in NIAE was of course in longer term and more scientific approaches to the engineering of agriculture and would be reflected in the pressures on the Institute's work programme to come.

The management arrangements for the Institute changed at the same time. The Agricultural Machinery Development Board set up in 1942 to oversee the Institute on the transfer from Oxford University to MAF, had its responsibilities split between two bodies. The British Society for Research in Agricultural Engineering (BSRAE) was legally constituted as a ''company limited by guarantee and without share capital'' to act as the Governing Body of the Institute, whilst the responsibility to advise government on the requirements and supply of agricultural machinery was passed to an Agricultural Machinery Advisory Committee. The first Chairman of BSRAE was Lord Radnor, who had also chaired the Agricultural Machinery Development Board.

Just before the move to Wrest Park, the NIAE's extension activities had been transferred to the new National Agricultural Advisory Service (NAAS), and their Report, *The First 8 Years 1946–54*, states 'As post war policy developed it became clear that efficient mechanisation would become a factor of increasing importance. There would be a need for advice on farm machinery and to meet this trend a decision was taken to appoint machinery advisory officers.' There is reference to the NAAS Liaison Unit set up at NIAE in 1947 and headed by MAF's Chief Machinery Officer. Cooperation and collaboration grew steadily with this part of the advisory service to farmers. For example, in 1953 the Liaison Unit had NIAE assistance in determining the best mechanical means of spreading different forms of gypsum, for land reclamation following inundation by the sea in the East Coast floods that year.

Research and testing

The 1950s were important for the consolidation of the regimes for tractor testing. The Institute played a major role in the production and establishment of the British Standard for Tests of Agricultural Tractors of 1951 and the European OEEC scheme introduced in 1959 (Chapter 3). In the mid-1950s the first concerns about how to achieve full value from machinery testing arose. Throughout the post-war period demands for tests had been maintained, but many were unpublished confidential tests of prototypes for manufacturers. These reports on prototypes had increased the confidence of the UK agricultural engineering industry in the testing work of the Institute (in the 1930s they had viewed the Institute's tests with suspicion – Chapter 1). The Director records in 1956 that while the testing service for manufacturers is of direct help to farming, the NIAE wishes to encourage farmers to read the reports. The need to ensure that the Institute's work benefited the whole community becomes a continuing theme from this point onwards. As time went on the need to serve not just the agricultural engineering industry and farmers, but also the public, with their concerns about the impacts of agriculture on the environment, became stronger.

Among the developing themes in the Institute's programme through the 1950s were work on spraying, forage handling and grain drying. The research on spraying had begun within the newly established horticultural engineering programme at Askham Bryan in 1946. In 1948 work on spraying plantation crops began, in collaboration with East Malling Research Station and NAAS, with the design of air blast nozzles and the construction of experimental sprayers. This area of research continued until the Institute closed, and beyond. The forage handling work included the development of a prize-winning new design of a small forage harvester for dairy farms. In drying studies, work was establishing key basic understanding, including the hygroscopic equilibria (equilibrium moisture contents) of grain and other materials. The potato harvester development in the 1950s was seminal, and was exploited by Massey Ferguson.

The role of the agricultural engineer in supporting agriculture outside the UK was appreciated from early in the life of the Institute. The first involvement in tropical agriculture was in the 1940s working with the agricultural corporations in East Africa, including the development of a groundnut harvester (Fig. 2.3). In 1955, a liaison officer from the Colonial Office was stationed at the Institute. In the same year a trip by the Director and David Manby to East Africa confirmed the need for a mobile testing unit to serve Uganda, Kenya and Tanganyika, and plans were drawn up for the Institute to train a team for the work. This became the East African Implement and Tractor Testing Unit. The liaison officer post was assimilated into the Institute strength in 1958 and staff were recruited to eventually become the Overseas Department/Division (Chapter 12).

On the whole the Annual Reports for the period 1947–1961 show steady progress and little sign of turbulence, emphasising continuity and stability with frequent references to the similarity to previous years. Thus in 1951/1952 it is recorded that ''the policy has continued along the lines mentioned in the report for 1949–51'' and the next year ''there has been a continuation of established policy and this includes many of the items decided on previously'' and then in 1957/1958 Annual Report ''there have been no major changes in policy or programmes of work since last year''.

Figure 2.3 – Groundnut harvester at work in Tanganyika – development started in the 1950s.

A parallel venture – the Scottish Station (1946–1974) and its successor (SIAE)

The Scottish Machinery Testing Station, otherwise known as the Scottish Station of NIAE, was established in 1946 after it was decided to move the principal location of the NIAE south to Bedfordshire. When MAF passed responsibility for NIAE to ARC in 1949, the Department for Agriculture and Fisheries in Scotland (DAFS) continued as funder of the Scottish Station, while the BSRAE, the Institutes' Governing Body, retained a role in the oversight of the programme until 1987. The Station was initially based in Howden (now part of Livingston) but moved to join other research stations on the Bush Estate, Penicuik, by January 1962.

In 1974 the Scottish Station became independent of the NIAE as the Scottish Institute of Agricultural Engineering, which in due course became the Scottish Centre of Agricultural Engineering within the East of Scotland College of Agriculture, and then was absorbed within the Scottish Agricultural Colleges. Strong working relationships were maintained with the Scottish Institute throughout, whilst seeking to maintain complementary programmes seen as appropriate to their geographical interests and the available expertise. It was agreed, for example, that the NIAE would focus on sugar beet research while the decision was made in 1968 that all potato work (except relating to storage) should be transferred from NIAE to Penicuik, which already had an active engineering programme on potatoes. This was sensible in that no sugar beet was grown in Scotland, but there were both potato growers and potato machinery manufacturers in England, and gentlemen's agreements were set aside when the latter expressed a preference to work with the NIAE. Geographical priorities were also ignored when opportunities were found later to exploit image analysis for the Scottish salmon farming industry. The NIAE Annual Reports included the work of the Scottish station and its staffing until 1974.

New expectations and conflicting roles (1962–1971)

During this period there was closer scrutiny of the NIAE programme by the Ministry of Agriculture, Fisheries and Food (MAFF – successor to MAF) and ARC, and by the farming community, and also changes that increased the Institute's focus on engineering research, though key practical strands like testing continued. It was probably no coincidence that these changes happened largely after the appointment of Charles Moss as Director in 1963, following W H Cashmore's retirement. It was said by some that 'Mr Cashmore was a real gentleman' whilst during his time the Divisions were less closely managed. Charles Moss may not have sought popularity but no doubt realised the importance of preparing NIAE to withstand closer external scrutiny and a more stringent financial climate.

In 1963, a Testing Advisory Committee was set up, reporting to the Governing Body, with members from the National Farmers' Union, the Agricultural Engineers Association and the National Agricultural Advisory Service, and with representatives of ARC, NIAE and its Scottish Station in attendance. This reflected the concern for the relevance of testing to machinery users which the Director had expressed seven years before. Confidential tests on prototype machines for manufacturers continued, and a 'Testing Scheme for Users' was introduced for production models. Publication of the report was compulsory unless the machine was withdrawn from the market. A subscription scheme for farmers was introduced.

These changes were encouraged by MAFF and in the late 1960s they took over the administrative and financial responsibility for testing for farmers and for the Testing Advisory Committee. For the Institute, this meant that the focus was solely on the professional engineering work of testing to scientifically and technologically sound standards, rather than the administration of the scheme. However, the engineering industry had misgivings and the AEA saw the scheme as 'badly designed' and '(receiving) nearly no support from the farmer customers whom it was primarily intended to help'. The Institute was also concerned about the low level of farmer interest in the reports (at its peak there were just 3000 farmers subscribing, at £3 p.a., out of the 350,000 or so in the UK) and it probably wasn't a surprise when MAFF funding was withdrawn in 1971. Today these same NIAE Test Reports are bought by vintage tractor enthusiasts on e-Bay, some titles fetching considerable sums.

New direction

The new Director, Charles Moss, came from the National Coal Board. He brought with him no agricultural baggage, and was therefore able to look at the role of an engineering Institute operating within a Research Council from a new perspective. The future organisation of the Institute was also evaluated in 1964 by a committee ''appointed to advise ARC and BSRAE on the future function and organisation of NIAE''. This appears to be the first formal Visiting Group, as the procedure became known. In the years that followed there were significant changes in the programme, of which the largest was the establishment of a significant programme of research relating to livestock production. The work on automation, instrumentation and environmental control was also strengthened. A further Visiting Group in 1968 supported the need for improvements in laboratories, offices and experimental working areas, and questioned whether resources were being spread too thinly over a large range of interests. Its conclusion was that the Institute must focus on engineering research at a time when resources were limited, and look to enhanced collaboration with biologists, agriculturalists, horticulturalists and others to deliver multidisciplinary work. Research at the interface between engineering and other areas of agricultural science took the greatest hit, an example being the transfer of plant physiologists from the NIAE Environmental Control Division to two sister ARC Institutes, the Glasshouse Crops Research Institute, and the rather nearer Rothamsted Experimental Station at Harpenden, Herts.

The decision not to employ plant physiologists or other biological scientists was unpopular at the time: after all, engineers could not work without a clear specification, and this must often be provided by agriculturalists or biologists. But with the exception much later of work on animal behaviour, the decision was never revoked. Close working relationships with national centres of biological expertise seemed

preferable and there was also the political expediency of being seen as an integral part of the family of Institutes.

These changes reflect the continuing concern to satisfy many masters. In 1971 the Director stated ''we are happy to discuss problems with (farmers and growers) and to have their criticisms''. This is not the last reference to the periodically tense relationship with some end-users, and the next year he records that ''there is little likelihood of our being able to do all the research which farmers and advisory officers encourage us to do''. The problem was that, although the original purpose of IAE at Oxford had been to give practical technical help to farmers, government support for research Institutes now tended to focus on the kind of science that is published in academic journals, not on the practicalities of activities on the farm. The Institute needed to work with the advisory service on practical problems, and with machinery manufacturers to put machinery advances into practice. However, with the need to innovate and provide underpinning scientific understanding came the need to focus resources so that real technical and scientific progress could be made – looking to the future. This was bound to place the Institute at a greater distance from many day-to-day industry needs.

The research programme at this time was diverse, and based on the expectation that agriculture would need to produce food of consistently high quality with less labour. Hence there was emphasis on automation of farming processes, materials handling and systems studies. Examples from this time include the development of well-based bins for fruit harvesting, which evolved from work on the experimental self-loading vehicle for orchards, and the blackcurrant harvester. The new focus on research related to livestock production encouraged by the Visiting Group in 1964 saw work on feeding controls, ergonomics, pollution control and animal weighing. Another new area of activity was the study at full scale of the wind loading on agricultural buildings – triggered by concerns following storm damage, and an underlying worry that regulation might impose unnecessary additional costs on the industry.

The Institute was a significant contributor to ergonomics in agricultural engineering from the early 1960s. Ergonomics aims to improve machine designs and work methods to benefit workers' health and comfort and to increase productivity. Farming had always been a hazardous occupation, and NIAE worked closely with those responsible for health and safety within government (the Health and Safety Executive after 1974) and contributed substantially to tractor drivers' health and safety from the 1960s through to closure, establishing testing procedures for safety frames and cabs, measurement procedures for the noise experienced by drivers, and research on ride vibration and seating (Fig. 2.4 and Chapter 3). In 1971 the Institute published a handbook 'Ergonomics in Agricultural Equipment Design'. Work on noise and vibration led to the development of a simple anechoic chamber for noise measurements made of straw bales. Other inputs spanned milking parlours, transplanters, chain saws, apple picking and combines – and a considerable body of work in the overseas development programme. It's worth recording here the award in 1997 of the President's Medal by the UK Ergonomics Society for the Institute's extended contribution to the subject.

Figure 2.4 – Physiological measurements for vibration studies.

The first steps into computing were based at Rothamsted. Rothamsted had received the Elliot 401 from Cambridge, and the statistical service was largely established on an Elliot 402 (later boosted to a 403). In 1963 a statistical computing service at Silsoe began with access to the Orion at Rothamsted. At Silsoe Doug Filby built an analogue computer, with 20 amplifiers, which was commissioned and used by John Matthews for tractor dynamics studies in 1962. Though only a small beginning, it heralded the arrival of computational methods that were to revolutionise the approaches to research over the next few decades. Not only was statistical analysis of experimental results made more accessible and sophisticated, but the scientific method could be applied to evaluation of agricultural processes and farming systems, and the physics and mathematics of underlying processes could be studied alongside or even ahead of experimentation. The potential was enormous and was soon being realised throughout the scientific programme of the Institute.

New buildings were underway in 1971 and 190 acres of land had been acquired since 1964 so that most field research could be done on site without the expense of travelling to more distant farms. But funding was not easy for ARC at this time, and the pressures from declining resources were from now on to be a feature of the management of the Institute in most future years. At this stage, the staff complement was over 400, and peaked in the early 80s at about 450 – the changes in the work programme were reflected in the mix of staff, with more than 60 in the workshops at this time, but declining steadily to less than 20 by the mid-90s.

The customer–contractor relationship (1972–1977)

In 1971 the Rothschild Report revolutionised the process of funding research in the UK. Immediately before the Report, the funding arrangements for NIAE were typical of many public sector research organisations. Funding came predominantly from the ARC, which had science responsibilities, while much of the ARC research was focused on strategic priorities of UK agriculture that were the responsibility of the Ministry for Agriculture, Fisheries and Food. The government commissioned two reports, one from Lord Dainton on

'*The Future of the Research Council System*' and the other from Lord Rothschild on the '*Organisation and Management of Government R&D*', published as appendices to the Government Green Paper '*A Framework for Government Research and Development*' in November 1971.

Lord Rothschild drew a distinction between basic (or pure) research and applied research. He recommended that applied research funded by Government should be the responsibility of the relevant Government department, which should therefore determine the objectives and expenditure, and also judge success. The department (such as MAFF) would thus be the customer for the research, and the research body (such as NIAE) would take the role of contractor. He suggested that 77% of ARC funds should be transferred to MAFF for them to commission applied research. In practice the transfer was around 50% – but for NIAE, with its practical engineering history and expertise, the transfer was close to 80%. The importance of basic research to underpin the applied work, ideally both in the same location or organisation, was clear to Rothschild, and always a strongly held belief in the Institute. But now that such a high proportion of Institute funding was to come from MAFF, it would be a continuing challenge to ensure that enough relevant new basic science could be pursued.

In accordance with the Rothschild dictum, the Research Council expected its resources to be used for basic research, and MAFF was given the role of proxy customer for the industry (i.e. farmers and manufacturers). [MAFF remained the majority funder of Institute research until the mid-1990s, but over the years this proxy customer role was substantially lost, and MAFF's successor, Defra – the Department for Environment, Food and Rural Affairs – funds research only to satisfy its own policy needs.] The Institute's own systems for project appraisal and review, developed during the 1960s by Charles Moss, provided the basis on which to convince the customer that projects were worth doing and would be well managed. They included assessment of the potential cost–benefit of the research.

As funding for research began to be restricted, the ability to respond to new opportunities by recruiting additional staff largely disappeared. The distribution of Institute research was also scrutinised more closely. In 1972 the Director noted that 30% of the annual budget was being spent on horticulture, and sought outside opinions. He had, the previous year, drawn attention to a report by the Royal Commission on Farm Machinery for Canada. This revealed that the Canada Department of Agriculture allocated only 1% of its $41m research budget to farm machinery research (whereas the NIAE was receiving around 6% of ARC funds) – yet the Commission concluded that this R&D was achieving considerable benefit at reasonable cost and that ''it could be argued that half the budget should go towards improvement of machinery and equipment''. This rather unrealistic suggestion provided comfort that engineering research was valued.

MAFF now sought the involvement of the farming industry in determining the priorities for research, through a Joint Consultative Organisation (JCO) with committees for different sectors and commodities although there was no JCO committee for engineering, so NIAE always had to stand up for itself and convince MAFF of the benefits of engineering research. The Institute already had its own advisory groups to provide insights on industry priorities for engineering innovation. These brought together farmers, growers, manufacturers, and advisers with staff from NIAE, SIAE and other research establishments.

Winning contracts and working with industry (1977–1989)

In 1977 the new Director, Ron Bell, took up his post. Coming from an academic engineering background, he made a point of visiting many farmers, manufacturers and research organisations.

This was a period of growing financial constraint for research Institutes and the NIAE was seen by some as introspective – Ron Bell realised that NIAE's future required better links with the industry and we had to build contacts. The success of this policy, attracting extra funding for commercial contract research, helped to balance the books at a time when all ARC Institutes were faced with post losses or even redundancies.

A Department of Industry (DoI) report on the agricultural engineering industry in 1978 spawned discussions involving NIAE and the Agricultural Engineers Association, and resulted in the Industry Tractor Scheme involving joint sponsorship by DoI and 16 UK manufacturers of tractor, components and implements, and in parallel a product evaluation and testing activity. The first Industry Tractor Contract (ITC) proposal was put together and promoted by John Hall of DoI and John Matthews. It lasted for three years and was succeeded by ITD and ITE at two years each, making this a major venture involving 40 staff, £2m, 12 sponsors and 5 contractors and subcontractors. Ron Bell's arrival and actions had ensured that industry confidence and commitment was attracted and sustained. The companies sponsored major confidential research and development contracts at the Institute, with some work subcontracted to SIAE and the National College of Agricultural Engineering (NCAE). A new building was financed by the Department of Industry for the purpose – prosaically known as the DoI building! The work led to the formalisation of the Agricultural Machinery Partnership (AMP) in 1984, in which the support of DoI (by then the Department of Trade and Industry, DTI) was strengthened by commitment from the government agriculture departments, and the partnership, administered by NIAE, sponsored research and development at NIAE, SIAE or elsewhere to advance the technological quality of the products of the UK agricultural machinery industry.

It was a most enlightened scheme with full authority vested in John Hall of the DTI, David White of MAFF, and the Directors of NIAE, SIAE and the NCAE. Following discussions with a manufacturer it was often possible to agree the funding and start work within a few days. In many ways AMP was a forerunner to the LINK scheme for industry and Government to fund research jointly, and had some considerable advantages over it from an operational perspective. LINK provided the model for collaborative government/industry funding across all sectors from the late 1980s, but invoked what at times was a stifling bureaucracy incurring major delays through the needs for government accountability and pre-negotiated intellectual property agreements, which were blissfully absent from AMP.

The Institute's Diamond Jubilee was celebrated in 1984 with justifiable pride; Sidney Cox's account of '*NIAE 1924–1984:*

Ron Bell, Director 1977–1984.

''My initial impressions of NIAE were somewhat mixed. At the end of my very first day in the Institute I found myself alone and locked in. It was about 6.30 pm but it was autumn and very dark. All the corridor lights were off and I had no idea where the light switches were and only a vague idea of how to grope my way into the basement where I knew there to be a door with a Yale lock that I could open and hence avoid being confined for the night.

The Institute seemed to be a place of great contrasts. On the north side of the drive there were the purpose-built modern laboratories: on the south side the historic buildings, originally a de-luxe private mansion but now bearing all the hall-marks of a frugally maintained public ''institution'' – cold and uninviting. In my early years in Wrest Park the word ''dreary'' was never far from my lips. Something more had to be done to improve the welcome for the many visitors and collaborators we wished to encourage and to give staff the infra-structure and confidence to greet them and to win their support.

The ''clerk of works'' seemed to have a very severe view of life with close attention to the letter of health and safety regulations. When I requested that the cloak room next to my office should be fitted with WC and hand basin I came back from a visit one day to find an enormously strong timber structure being erected around the WC. Allegedly this was a requirement of some new health regulation. I decided in favour of a less healthy solution.

There were similar contrasts to be found among the staff. Some were full of confidence and fighting spirit. For instance when I first met Wilf Klinner he recommended that my top priority should be to remove all managerial brakes. Having spent the previous twenty years in Universities where expansion and rapid development were the order of the day I was not looking for the brakes but for the accelerator pedal. But just as the buildings were of two kinds so were the staff. Not all were as confident or bullish as Klinner. Some had been left behind by the changing requirements placed upon the Institute. Socially too there were those who had been left behind by changing standards. Our hostel at the village end of the drive where some of the unmarried staff lived on a permanent basis was not simply uninviting – it was spartan.

The ARC was itself having difficulty in reconciling itself to changing circumstances. For instance when I wished to encourage staff to go out and win industrially-funded work, the headquarters staff were very nervous and it took the chairman of the Governing Body and me some time to persuade the Council that this was the path to tread.

Happily we were all soon pulling in the same direction and over the next seven years I enjoyed one of the most satisfying periods of my professional life.''

60 Years of Agricultural Engineering' records 450 staff (though this probably reflects the complement of posts, not all of which could be filled at one time) at Wrest Park, and that 'nearly 40 items of equipment on display [at the 1983 Smithfield Show] had resulted from NIAE research or from joint developments with manufacturers' (Fig. 2.5).

In 1984 Ron Bell moved on to a new challenge as Director of MAFF's Agricultural Development and Advisory Service (ADAS), and John Matthews became Director of NIAE.

By 1983/1984 the Institute was earning about 18% of its income from contracts to supplement the core funding (administered by the Research Council) of 55% MAFF commissions and 27% science budget support from the Department for Education and Science. At this time MAFF was also introducing its open competition contracts for research. These were generally three years in duration and were advertised openly for any research contractor to make a proposal. It was clear that they met a political priority to

Figure 2.5 – The Institute exhibited at the Smithfield Show for many years with large displays in the 1980s and early 1990s (Nobby Grundy is next to the tractor).

increase the levels of competition in research provision and widen the contractor base for MAFF.

The Research Council added the word Food to its name in 1983 (becoming the Agriculture and Food Research Council, AFRC), reflecting the government's concern for more research in food science and technology. AFRC decided that NIAE should be its specialist Institute for engineering research, thus encouraging the exploration of ways to contribute to the efficiency of food processing in the UK. Initial studies were focused around sensors and control systems, though it wasn't until the mid-1990s that the Institute was recognised as bringing a novel and relevant contribution to the research needs of the food sector.

By the mid-1980s the funding problems for AFRC Research Institutes had increased. The greatest pressure came from within the Research Council itself, where the academic members, experiencing pressures on funding from government to universities, pointed out that, of all the research councils, the AFRC spent the smallest part of its funds in universities. The universities believed that they could deliver the research at least as well, especially where modern science was required, and the Advisory Board for Research Councils pressed AFRC strongly. AFRC was supporting around 25 independent Institutes and recognised that it could not sustain them all. These Institutes were therefore restructured by merging some and closing others to leave eight in total: three for plant research, two for animals, one for grassland and environment, one for food and one for engineering. At the same time the Department of Agriculture and Fisheries (Scotland) was reviewing the position for SIAE and deciding that it should become a part of the East of Scotland School of Agriculture. These major changes left NIAE seemingly in a strong position as the only provider of engineering research and with a history of collaboration with other Institutes (Fig. 2.6).

They also brought pressure for conformity, such as names in a standard style, and in 1986 the name NIAE passed away and we became the AFRC Institute of Engineering Research,

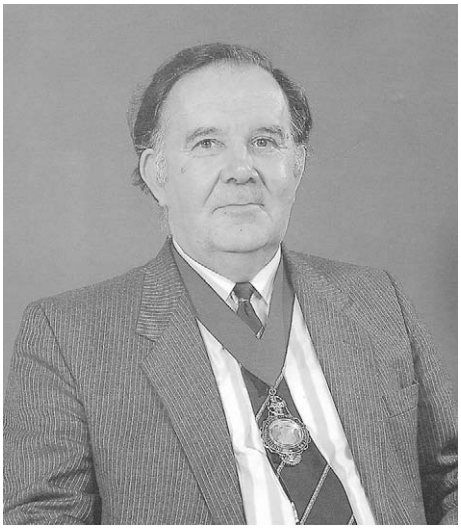
Figure 2.6 – AFRC Engineering logo.

often abbreviated to AFRC Engineering (and triggering many phone calls from companies looking for a jobbing engineering business). AFRC reduced the Institute's grant in 1983 and 1984, and there were MAFF reductions in 1986 and 1987. Fortunately contract funding was growing steadily, providing some cushion that reduced the post losses necessary at the Institute.

European links

The European Commission began to be a significant new source of contract funding in the 1980s. Their Research Programmes provided opportunities for substantial projects, though the requirement for multiple partners from across Europe, and an application success rate that was often as low as 10%, made them a frustrating target. The Institute had considerable success, thanks to the initiative of John Matthews in bringing European agricultural engineering research organisations together, and the efforts of Laurie Osborne in marketing our expertise and activities in Brussels and around Europe.

The first step in building this rapport with Europe had been taken by Ron Bell, who initiated an international conference, AgEng 84, aimed particularly at European scientists and organised at Cambridge by the Institute to celebrate its Diamond Jubilee. The success of this as an international scientific meeting for agricultural engineering in Europe led to its establishment as a biennial conference series that is running to this day. The next initiative was the founding by John Matthews of the European Community Club for Advanced Engineering in Agriculture (ECCAEA) in 1988 (Fig. 2.7). At the outset there was a most intriguing debate on what should be the official language of the Club, especially at the biennial conferences. All agreed on English, but French delegates insisted that French should also be nominated. The English delegates decided tactfully not to comment, and other nations devised the compromise that English would always be used, but the host nation could, at its own expense, provide simultaneous translation! Directors and research leaders from the leading Institutes and universities of agricultural engineering met to identify priority problems and the opportunities for new engineering research to tackle them. This was vital at a time when surpluses and quotas were bringing the Common Agricultural Policy under critical scrutiny. One particular aim of the Club was to provide a forum to make direct representations to Brussels.



John Matthews, Director 1984–1990.

''On joining the NIAE in 1959:

- *I gained confidence (and some prestige) when as an SO I was able to reverse a tractor and 4-wheel trailer combination. (I had been driving tractors from 9 years of age!)*
- *I lost confidence (and some prestige) at the first social event I attended when, in the Paul Jones dance, I 'landed' opposite Miss Fenton, the fearsome Finance Officer. Her physical and mental power ensured that we went exactly where she wanted.*

On becoming Director in 1984:

- *I recall a strong feeling that it was* **our** *Institute. We were a 'family' and it was important that one of* **us** *was in charge.*
- *Nevertheless, I felt that I had a good partner, as I remember going up to the newly unveiled statue at the top of the main staircase and patting its wooden buttocks saying ''well old chap, it's up to you and me now''!*

On retiring in 1990

- *Then and many times since I have thanked God for giving me the best job in the world for 31 years. The variety of challenges, the fascinating solutions, the world-wide travel and – not least – the Wrest Park family of friends and colleagues. Who could ask for more?*
- *There are so many delightful memories, which we supplement by paintings of Wrest Park in our hall. Hearing of the intended closure was just like suffering bereavement, but we know it was worse for those still working at the Institute and our thoughts have been with them.''*

The contacts made at the AgEng conferences and the Club meetings provided a strong basis for collaborations in successful EU proposals over the following years. Again Marketing made a critical contribution. The first challenge was gaining the ear of the Commission in Brussels; Laurie Osborne built up contacts with the EC Programme Managers who formulated the EC programmes of research. They were keen to engage in a dialogue, explaining their requirements and asking for ideas for research projects that would be timely and appropriate for inclusion in new Programmes. Another was seeking appropriate partners and Laurie spent much time visiting research centres in the EC to identify suitable partners, putting Institute staff in touch with the right individuals and then helping them thrash out research proposals.

Government reviews

In 1988 a government white paper ''*DTI – the Department for Enterprise*'' set out a new principle for public expenditure on R&D. The government believed that this should only support work that was far from the development of a marketable product or process – ''near-market'' research was not appropriate. The idea was essentially a device to reduce public funding, but the scope for the agriculture industry to respond by funding research itself was uncertain because of its fragmented nature. MAFF challenged the approach, highlighting this 'market failure', and at least got the acceptance that levies on the industry would be needed to support near-market research. The reduction in government funds triggered further review for the Research Institutes. For AFRC Engineering, the biggest concern was the MAFF (Barnes) Review of near-market research within its commission portfolio; finding engineering solutions to agricultural problems might be considered too near-market for government funding. With relief we learned that just less than a quarter of our MAFF funded work was judged to be near-market, much the same as at other AFRC Institutes. The result was to be a progressive withdrawal of 13% of total Institute funds.

Figure 2.7 – EC Club inaugural meeting. L to R (back row), M. Le Bars (Director CEMAGREF), M. Berger (CEMAGREF), Ir Hagting (Director, IMAG), Prof. Pellizzi (Director, Institute of Agricultural Engineering, University of Milan) (front row), Mrs Field (Technical Secretary), Dr Jahns (FAL), Prof John Matthews, Mr Perdok (IMAG), Miss Jones (interpreter).

The optimistic conclusion was that contract funding could fill the gap.

There followed a long sequence of further government reviews addressing the structure of research organisation. The House of Lords Select Committee under Lord Butterworth concluded that AFRC and NERC (Natural Environment Research Council) should be amalgamated in a Natural Resources Research Council. This suggestion was warmly welcomed by John Matthews who saw the real opportunity for engineering innovations to tackle the environmental issues that were increasingly important. However, this report ended in the long grass. Another significant review produced the Ibbs Report on '*Improving Management in Government: The Next Steps*'. This began to challenge the natural order of government research being done through organisations that were directly linked to government or, like the AFRC Institutes, on its fringes. In the end it had no effect on the Institutes, but it did decide that the advisory service ADAS should become an Executive Agency. Our long time partner at Wrest Park, the ADAS Mechanisation Unit, was part of this, and soon moved away from the Park, and largely disappeared as ADAS shrunk.

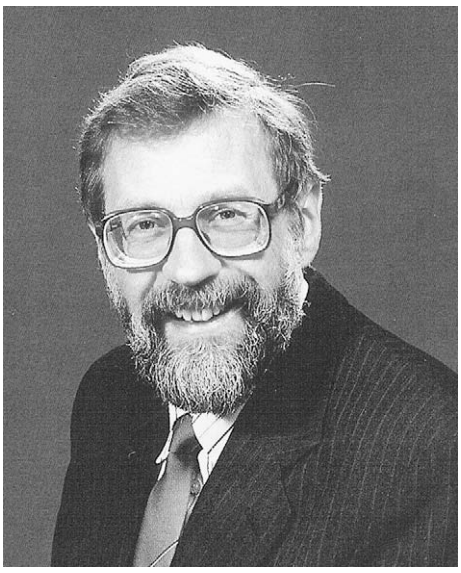
Science into practice despite sustained turbulence (1990–2003)

As the 1990s began, the success of our science in delivering innovations into practice was well known to our main funders, and MAFF's decision to withdraw from near-market research was matched by a commitment from AFRC to increase funding for basic science. Thus we were able to strengthen our investment in key areas of new science, including robotics and information technology, and develop them appropriately for the agricultural and food sectors. Contract funding at around 20% of the budget was often related to the more applied aspects of the Institute's work that had been maintained since the earliest days. The Testing Group still undertook testing of tractors, now for international companies, and with a strong emphasis on health and safety.

The government LINK scheme for funding research jointly with industry had also begun at the very end of the 80s, and the Institute was one of the most successful for its size with funded projects in programmes such as Design of High Speed Machinery, Sustainable Livestock, Sustainable Arable, and Advanced and Hygienic Food Manufacture. An early LINK project, with Loctronic International, developed image analysis and control for the high speed grading of potatoes, turned into a commercial system by Loctronic and Sortex. One of the last LINK projects was also image analysis-based, using webcam technology mounted on a guidance hoe to achieve mechanical weed control effectively and at competitive work rates. Others ranged across the Institute's capabilities, such as spray technology, tractor power, and gaseous emissions from animal production; some of the outputs were guidelines on fogging food factories, patents for localised cooling and appropriate technologies for treating dirty water on dairy farms.

Brian Legg became Director in 1990, with new opportunities through increased research council funding, but also facing the difficulties of staff reductions as MAFF funding was reduced and redirected.

The Institute's distinctive contribution in engineering and science was as strong as ever, as he made clear in a video produced in 1995 for the 50th anniversary of the United



Brian Legg, Director 1990–1999.

''Wrest Park – what wonderful surroundings – this was everyone's first impression, especially visitors from overseas, though industry disapproved, assuming wrongly that our costs included the upkeep of the house and grounds. When John Selwyn Gummer visited as Secretary of State for Agriculture, Fisheries and Food, he commented that the Director's office was rather better than his, and that in an earlier era he would have had me executed and moved in!

But the feature of Silsoe that made the greatest impression was the ingenuity and versatility of the staff. The best were doing excellent science to understand the problems they were trying to solve, but were equally determined to use that knowledge to make a new machine or design a new process that would bring real benefits to agriculture. These qualities attracted comment from many outside, and I recall Andrew Blake from Oxford University (later a member of the Governing Body and Fellow of the Royal Academy of Engineering) saying that he admired our staff for being able to put so many different technologies together and make them work. Shortly after arriving at Silsoe I described some of the work to a friend who was an aeronautical engineer. He was most impressed that one small team could be responsible for the preliminary research, and also for the design, build and testing of the prototype – an engineer's dream! As an aeronautical engineer he spent all his time designing the third panel out on the left wing of an aeroplane.

Perhaps the most significant change to occur during my time as Director was for the Agricultural and Food Research Council to be re-constituted as the Biotechnology and Biological Sciences Research Council. Whereas Silsoe's work was easy to defend in the context of agricultural and food production, it was never so clear how we fitted into biotechnology and biological sciences. Professor Tom Blundell, who was chief executive of the BBSRC at the time, took the enlightened view that all of our engineering was biotechnology. But when his successor, who came from the pharmaceutical industry, spoke of ''farmers'' he was spelling it ''pharmas'', and I knew that life was going to get more difficult. None-the-less I was surprised and saddened when moves to close the Institute came so quickly. I would like to pay tribute to Bill Day and the Governing Body, who fought hard for the Institute and produced a superb paper for BBSRC Council showing that Silsoe had delivered all that was asked of it in the 1990s and early 2000s, and had outperformed almost all of the other Institutes in terms of benefits to the industry and working with industry. But none of this could compensate for the fact that the majority on Council cared only for advances in fundamental biological science, and in this context Silsoe could not deliver.

The impact of engineering on food production in the 20th century was huge. I recall an HGCA conference at which one speaker boasted that agronomists had increased crop production by a factor of 2 to 3 in the last 50 years. I was able to respond that over the same period engineers had decreased the labour requirement by a factor of 8 and were chiefly responsible for the dramatic fall in food prices. I cannot, of course, attribute all of that progress to research at Silsoe, but there can be little doubt that we made an important contribution.''

Nations. This celebrated the contribution to world food production through advances in agricultural engineering research and international collaboration.

With our new emphasis on basic science, the AFRC Engineering name was less appropriate. Few recognised it and many responded by saying ''Oh, you mean NIAE''! That we needed something more distinctive and indicative of research for a wide range of industry had been apparent for some time. Our commitment to agriculture and food was unchanged, but we must also contribute to the environment, animal welfare and the food chain, and beyond. Thus ''Silsoe Research Institute'' was chosen, associating the Institute and its research strengths with the one unchanging factor for the preceding 40 years – Silsoe (Fig. 2.8).

In 1993 the government signalled a radical change in its thinking about science and industry in the White Paper '*Realising our Potential*'. The new policy was to 'harness the UK's strength in science and engineering to the creation of wealth and improvements in the quality of life' by fostering partnership between industry, government and research. It

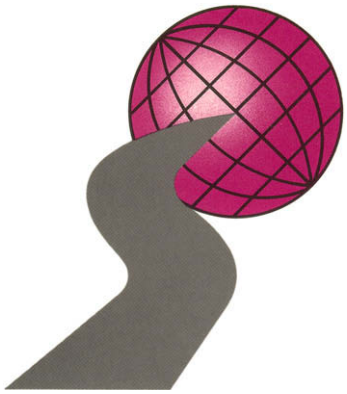


Figure 2.8 – SRI logo.

sought to knock on the head the old cliché that the UK was good at science but poor at getting it into practice. The objective, to deliver benefit through innovation in industry fitted well to the Institute's experience and capabilities. However, changes to the research council structure were also proposed, to concentrate research in those areas that UK industry was best able to exploit. The biological sciences were seen as a priority, to serve a strong biotechnology industry. So the Biotechnology and Biological Sciences Research Council (BBSRC) was formed in 1994, taking over agriculture and food from the old AFRC, and with it our non-biological science.

In 1994 and 1995 Government set up two successive reviews of 53 public sector research establishments. The review process was known as Prior Options. The conclusions of the first, that privatisation was not an option for most, were rejected and the second review was instituted with the aim of ''limiting public sector capacity to the minimum necessary to meet the Government's statutory responsibilities and other essential requirements''.

In May 1996, in response to a question in the House of Commons, Mr Ian Lang, President of the Board of Trade said ''Prior options reviews have been completed of the Institute of Arable Crops Research, the Institute of Grassland and Environment Research, the John Innes Centre and the Silsoe Research Institute. I am satisfied that the functions of these Institutes are needed and that they should retain their separate existence … I have concluded that full independence from the public sector, with the greater freedom this will provide the Institutes to direct their own affairs, would be a desirable option which merits further consideration''. So the Institute was still in the frame for privatisation.

In a House of Lords debate in November 1996, during the Prior Options process, Lord Lucas (of Crudwell and Dingwall) said ''A further 19 agricultural research establishments are currently being reviewed in the Prior Options programme. One of those is an establishment in which I have a small interest, the Silsoe Research Institute, which occupies a house which marked the beginning and the end of my family's fortunes when it was built. How they deal with that liability, should it be privatised, I wait to see.'' Lord Lucas's family line includes the de Grey family and his family had occupied Wrest Park for many centuries until the early 20th. The query he raised over the liability for the house presaged a significant exercise at the time of closure 10 years later.

The decisions on the Prior Options review were finally made in January 1997. For SRI and the other BBSRC Institutes, there was no proposed change, but ADAS, an Executive Agency of government since 1992, was recommended for full privatisation and became ADAS Consulting Ltd in April 1997.

During the 1990s, our funding from the BBSRC for basic science grew to over 30% of turnover. At the same time, the Institute was still delivering much value through the MAFF and contract work, often leading to practical innovations that had a big impact on the market place. The commercialisation of the Institute's work on robotic milking of dairy cows through Alfa Laval (now DeLaval) was highly successful and their Voluntary Milking System is now a market leader. The decade also saw a steady growth of research students, working alongside all aspects of the research programme and bringing fresh eyes and ideas.

MAFF began a shift away from the commissioning process, so that within a decade 90% of our MAFF funding was for short term contracts, for periods ranging from 6 months to three years, instead of for longer-term strategic programmes. Moreover, we had less input into the decisions. Originally, Commissions had supported strategic research on applied problems; they were reviewed, with external advice and joint discussion of priorities, every three years, but there was an expectation of continuity. Now when commissions were reviewed they were often terminated or put out to competition among other research providers. In addition, MAFF was now determining priorities internally; for a time, research funds were controlled by its Chief Scientist's Group, but later on by a multiplicity of MAFF Policy Groups. Physical scientists of any kind, let alone engineers, were almost non-existent within MAFF so that it was difficult to convince the Policy Groups that engineering had a major contribution to make. Delivering research and innovation across nearly all the policy areas of MAFF was a major triumph for the Institute, demanding considerable effort to keep MAFF informed and responsive to engineering opportunities.

The demise of MAFF in 2001, with a merger with government environmental interests to create Defra, the Department for Environment, Food and Rural Affairs, might have opened new opportunities. Unfortunately the Foot and Mouth outbreak that year, whose cost had to be borne across the Defra budget, hit research significantly.

Through this decade of organisational uncertainty the importance of the science base in justifying the existence of the Institute grew ever stronger. Since the 1960s the Research Council had appointed a Visiting Group every four or five years to review the performance of the Institute; these assessments were now using similar measures of success and academic esteem as used in the Research Assessment Exercise for university science departments, such as citations of papers in academic journals. The classic judgements of the performance of an engineering enterprise, like translation of science into practice, were considered to be secondary measures of lesser value. The Royal Academy of Engineering shared our concern, arguing in their report ''*Measuring Excellence in Engineering Research*'' in 2000 that engineering research could only be properly assessed if the criteria included multidisciplinary work and exploitation mechanisms. Their arguments had

limited impact at the time but were well understood by those at the Institute seeking to ensure our outputs were valued.

One of the products of the increased science funding during this period was the strengthening of programmes linking physics/engineering science and practical solutions. Three areas serve as good examples. Machine vision research provided many new mathematical tools, and an enhanced understanding of how to address the variable state of biological objects and the environment in which they were viewed. This work led to new practical techniques for animal monitoring and mass estimation and to new techniques to control field machinery. New approaches to fluid dynamics in the context of the dispersal of fine particles in turbulent flows produced a strong stream of fundamental papers in major physics journals, and also provided new insights into the dispersal of micro-organisms and fine sprays. Novel equipment for food factories was a direct result, and this interest in hygiene also led to a patent for improved hygiene in hospital operating theatres that was taken up commercially in the last year of the Institute. The third example area is the detailed studies of spatial variability, which developed and demonstrated the value of new statistical tools in analysing and extracting value from complex and extensive data on crop yields, soil properties, etc. The approaches provided a much stronger base to new ideas in precision agriculture than had been previously available.

The 2001 Visiting Group highlighted, as SRI's distinctive contribution, the way we were exploiting our science base by addressing a breadth of similar problems with biological systems ''at real scale, in real time and on real-life systems''.

Before describing the final phase for the Institute, some general activities throughout the Wrest Park years deserve a mention.

Contacts and communication

As we have seen, the Institute had continual dialogue with its funders and sponsors, reacting to their demands and criticisms throughout the decades. The most important means of maintaining contacts with the users of research were Study Groups and Open Days. Our scientific publications communicated our own and other work to the world-wide agricultural community. It was always Institute policy to foster links with engineers and scientists from home and abroad, who made short or longer-term visits to work with us. Acknowledgement and accolades in the form of patents and awards were many, and there were benefits from the geographical proximity of other professional organisations.

International collaboration

The first recorded post-war contact with the outside world and the start for ''overseas visits'' was Cashmore's visit to Germany in 1946 for the British Intelligence Objectives Subcommittee (BIOS), contributing understanding of the German agricultural engineering industry for the UK Government. ''Intelligence'' soon gave way to ''collaboration'' which was a critical part of the development of the Institute's role nationally and its reputation internationally.

In the 1960s, fact-finding missions to the US by several Institute staff were financed by the Hatley Foundation, set up by the Astor family ($2000 to be collected on arrival in New York!), at a time when we had our first Astor as Chair of the Governing Body. Throughout all periods in the Institute's history, we shared our expertise and knowledge, collaborated and liaised with scientists at the highest international level, including extensive input to European and international standards and codes of practice. In return, visiting scientists, often sponsored by the British Council and from countries in Eastern Europe, Africa, North and South America, New Zealand and China (in fact, from most corners of the world) enjoyed, we hope, both cultural and academic stimulation at Wrest Park whilst collaborating on joint projects.

The 1995–1996 annual report records a total of 34 foreign university departments and another 36 overseas Institutes with whom we were working at that time. The era of EC funded research strengthened our ties with similar Institutes in Europe. The CEMAGREF Institutes in France and IMAG in the Netherlands in particular were strong partners for many years in seeking solutions to research problems common to our Northern European agriculture. Further afield, our international development staff covered most of the globe, working on contracts to improve agriculture and alleviate poverty, whether it be in Bolivia, Bangkok or Bophuthatswana.

Credit must be given to our enthusiastic staff, who fostered good relationships with overseas scientists, and were able to produce scientific papers linking the work done in laboratories many hundreds of miles apart.

Publications

From the earliest days NIAE was active in publishing both its own agricultural engineering output and collecting and publishing information from the international engineering community.

The Institute's Library and Information Deparent had always collected agricultural engineering information from around the world since its Oxford days (*Abstracts of Current Literature and Notes* 1931–1937) (Fig. 2.9). This continued with various name changes and financial support from the Commonwealth Agricultural Bureaux (CAB) to produce an index to world agricultural engineering for many years until it was eventually incorporated into the electronic CAB database as used today. Until the 1990s NIAE always boasted a complement of translators who could master texts in many a European language, producing English translations of some of the major engineering research articles published abroad.

The direct involvement of the Institute in scientific journal publishing began in 1956 when the Secretary of the ARC asked the Institute to take responsibility for publishing the *Journal of Agricultural Engineering Research*. JAER, as it was always known, was the main vehicle for publishing Institute research and also available for non-NIAE engineers and scientists to submit research papers.

During the 1990s, the basic science content of the Institute's research was growing and demands were made on our scientists to publish in prestigious scientific journals appropriate to

Figure 2.9 – Studious staff (including Jane Rollinson, Keith Hammond, Neil Reilly, Jim O'Hara, Carol Kozak, and Bill Course) in around 1980 in the Institute Library, originally designed and built for Earl de Grey in 1836.

their subjects. These judgements were often guided by the outputs of bibliometrics like the Impact Factor of journals, which sought to reflect the demand for and quality of the science. This reduced the proportion of the Institute's research output that was published in JAER, whose broad remit led to a lower than optimal impact factor. However, the journal at this time was growing very rapidly – it had doubled in size between the mid-1980s and mid-1990s and was to double again by the time of closure. In 2002 the name of the journal (JAER) was changed to *Biosystems Engineering* – the title Biological Systems Engineering was briefly toyed with, but the abbreviation to BSE was deemed to have too many bad vibes. This name change was a response to what was by then an international trend to diversify the targets for our kind of engineering skills and demonstrate how they could and did improve the performance of a wide range of biological systems.

In the late 1990s, Christopher Wathes laid down a challenge to staff to get a paper published in Nature – and eventually this was met by Murray Lark in 2005. He had developed a range of techniques to analyse spatial variability in soils and crops, underpinning the development of realistic scientific approaches to Precision Agriculture in crop production. The paper related to the use of some of these techniques on wider concerns with carbon losses from soils (work led by Cranfield University) – but by the time the paper appeared Murray Lark and the soils work had transferred to Rothamsted as closure loomed.

Open Days

Open Days became a regular feature during the Askham Bryan days and continued at Wrest Park, enabling staff to talk face-to-face with individuals in the agriculture, agricultural engineering and food industries about the programmes of work and advances being made at the Institute. The BSRAE membership scheme kept anyone interested in the aims of the Society (to promote agricultural engineering) informed about the work of the Institute. The scheme, started in 1958, had reached 600 Members and Fellows by 1963.

In 1977 Ron Bell had, on arrival as Director, recorded that too many of the farmers, farm machinery manufacturers and research organisations he had visited were still unaware of the Institute's work. Communication was an increasing priority in the next decade, not just to demonstrate what had been done but also to look to the industry to fund studies and projects that gave them direct benefit. As a result, in 1979 a new BSRAE Association was launched as a commitment to communication, and membership reached 800 by the 1980s. The Institute formally acknowledged the importance of marketing by appointing David Manby as the first Assistant Director (Marketing) in 1982.

To complement Open Days, Subject Days were introduced from 1964 and proved a long lasting method of communicating with the industry until the 1990s. The first two were on ''The Control of Glasshouse Environment for Tomatoes'' and ''Tractor Operator Comfort and Safety''. They had two big advantages: their focus on a topic in depth which was attractive to industry people; and the involvement of other organisations in presenting their work, so a balanced picture of priorities and progress could be made.

A special Open Day marked the 50th Anniversary of the Institute in 1974 and was an opportunity to recall and demonstrate to the agricultural and research community, our customers and users, the value of what we had done and the

Figure 2.10 – The SKF Archimedes Award for Excellence in Engineering presented to Prof Paul Miller and his team (John Bodle, Barry Ambler, John Stafford, Paul Miller, Andy Lane, John Power, Mark Paice) in 1992 for the patch sprayer.

potential for the future. The celebration was opened by the President of the Farmers Union, Sir Henry Plumb, in a ''spirited style'' that ''stimulated and encouraged us all''. With 6000 visitors attending the main and subsidiary days, the anniversary was a great success though it was estimated to have cost 5% of the total running costs of the Institute for the year to stage. The 60th anniversary of the Institute in 1984 was marked by extensive static and moving displays of our work and that of SIAE at the Royal Show, manned by 20–30 staff.

The Open Day in 1998 was addressed by the newly appointed Minister for Science, Lord Sainsbury, and in 2000 by Lord Haskins, Chairman of Northern Foods and a government adviser. These meetings raised the profile of the Institute with key players at the interface between agriculture and food, and in other sectors. The broad relevance of the major science strands in the Institute's programme was emphasised, e.g. fluid dynamics addressing food hygiene, pesticide dispersal and pollution dispersion, and robotics and image analysis providing tools for increasing precision in relation to agriculture, food and environment targets. The work on food hygiene also led to collaboration with the Health Protection Agency, whilst that on spatial variability of crops and soils led to collaboration with the British Geological Survey in detecting environmental contamination with heavy metals.

Study Groups

There was concern about user involvement in the 1960s and the Institute recognised that a strong voice from the industry, speaking positively and knowledgeably about the work at Wrest Park, would be essential if public funding for both research and testing was to continue – and preferably to increase. To try and achieve this, Study Groups were established, where industry

and research representatives met to consider specific problems in industry sectors, and made recommendations to the Governing Body. They also facilitated collaboration with industry and provided a channel for dissemination of results, proving themselves enormously valuable.

They continued for decades, being restructured and renamed Strategy Groups in the 1990s but retaining the same essential goals – to bring together interested and influential individuals from the farming and agricultural engineering industries and from sister research organisations to help to identify the strategic directions and opportunities for research needed by the industry. Over the lifetime of these Groups, hundreds of individuals must have contributed their time and expertise, and their commitment and support were a great encouragement to the research teams.

Patents, awards and prizes

One of the key ways in which the Institute demonstrated the quality of its engineering ideas and their practical value was through patents and licences. Though patents had featured in the development of the Institute from the first days (with Owen's drying patents, Chapter 1) they began to take centre stage from the 1960s. The automatic moisture content controller for grain dryers was licensed in the mid-1960s and earned NIAE a five figure sum. In 1972 the blackcurrant harvester and grass cutting and conditioning equipment were being taken up by the National Research Development Corporation (NRDC – set up in 1949 to patent and commercialise inventions arising from government and university funded research). NRDC licensed the use of these technologies in return for royalties.

The mower conditioning patents, based on the work by Wilf Klinner and his team, were successfully licensed through the British Technology Group (BTG – the NRDC's successor in 1981) and the technology dominated the European market for conditioning machinery during the 1990s. By the mid-1980s the number of patents held on behalf of the Institute by BTG exceeded 90. In the 1990s the increasingly commercial approach of BTG led to a reduction in the number of patents that were sought, but a greater proportion of them were under licence. The stripper header (again based on Wilf Klinner's work) was a major success and others brought in smaller returns. The stripper patents also generated a lot of arguments and legal challenge about ownership of intellectual property and rights to licence income, and this absorbed a lot of time and effort in the late 1980s and early 1990s. Successful resolution was achieved to the relief of all. The robotic milking work that had been taken up by DeLaval also produced a significant income stream in the early 2000s.

There were also awards for many of the products reaching the market that were based on the Institute's ideas and innovation. A snapshot given in the 1978–1980 Annual Report records RASE medals for the Howard Rotadigger (1978), Standen's sugar beet machinery, which incorporated the NIAE cleaner, Hunday out-of parlour feeder and the Farrow slurry separator (all 1979). It also lists the Grower Challenge Cup in 1979 for the MJF tractor/transplanter self-steering system, to an NIAE design, and the International Dairy Event Supreme Award to Fullwood and Bland for their concentrate dispenser, based on NIAE design principles. There was also an award from the horticultural industry to Rex Sharp for his design of the cross flow fan sprayer.

The Institute continued to pick up awards in the 1980s and the most prestigious was the MacRobert Award in 1985. This is the UK's premier award for innovation in engineering from the Royal Academy of Engineering, and the Institute was a joint winner for its work on forage conditioning machinery (Rolls Royce shared the award for their work on techniques for high energy X-ray examination of gas turbines during testing). The successful licensing of Wilf Klinner's inventions led to two Queens Awards for technology innovation, for the mower conditioner (1984) and the stripper combine (1991). The SKF Archimedes Award for Excellence in Engineering was awarded to Professor Paul Miller and John Stafford and their teams in 1992 for the patch sprayer (Fig. 2.10).

Awards recognising value to industry continued to be a source of pride and in the Institute's last few years they included the BCPC Medal in 1997 to Paul Miller for his work on crop spraying, the RASE Research Medal in 2002 to Christopher Wathes for his work on environmental management of livestock (and three previous members of staff had won the RASE Research medal – John Hawkins in 1969, John Matthews in 1983 and John Marchant in 1992), the RASE Technology Award to Peter Kettlewell (2000) for his work jointly with Malcolm Mitchell of Roslin on animal transport and to Nick Tillett (2005) for his work on vision-guided hoeing for weed control, and further afield, Brian Sims won the Colegio de Ingenierios Agrónomos de Bolivia 2000 award for his contribution to agricultural engineering in Bolivia and the Kishida International Award from the American Society of Agricultural and Biological Engineers in 2002.

Friends, colleagues and collaboration within the village

For such a small village, Silsoe was an important centre for agricultural engineering in the UK. Not only did it have our Institute at Wrest Park since 1947, but in 1962–1963 the NCAE was established on the outskirts of the village; the Ministry of Education selected the site partly due to available farming land but also to enable the proposed College to be ''coordinated'' with the facilities at Wrest Park.

Over many years there was indeed coordination, collaboration and competition for funding. Some students, both from the UK and overseas, who were registered at the ''the College'', spent much of their time working on post-doctoral research on our site but with the benefit of two centres of expertise. Senior staff and directors of the Institute served on College committees and similarly College staff sat on Institute boards and Study Groups. Several successful students were appointed to our staff and thus helped to maintain healthy links with the College. Latterly the College became part of Cranfield University, with its areas of research and training changing direction towards the biosciences. On our closure the reverse transfer of staff took place with some Institute staff moving to Cranfield to continue their research.

By 2007, Silsoe had lost both the Institute and Cranfield University's agricultural engineering campus which was

transferred to their Cranfield site. A third organisation, which is also due to leave the village for Cranfield, is the Institution of Agricultural Engineers, whose offices have been on the College campus since 1974. This professional body enabled our staff to keep in touch with fellow members, attend lectures, promote our research and be at the forefront of developments within the agricultural engineering profession.

Closure and beyond

In 2002 BBSRC engaged with its stakeholder community (industry, other research funders and research organisations) to develop a research vision for the Council for the next 10 years – ''Towards Predictive Biology''. The strongly quantitative nature of this vision reinforced the need for a significant role for physical sciences and engineering in the delivery of advances in biological systems. Precision Agriculture was a specific part in the Sustainable Agriculture theme. However, BBSRC interest was concentrated in genomics and post-genomics. The new topic of 'systems biology' building strong interdisciplinary research from biological, physical and engineering science potentially held new opportunities, but new funding was confined to the university sector.

For the Institute, with its expertise in sensors and monitoring, and in environmental systems, the logical development was to relate to wider communities, for instance those with interests in hygiene and environmental pollution. These topics were more peripheral to the BBSRC vision. However, there were also pressures nationally to have a more integrated approach to research and provide more open access to the funds of all Research Councils, and this suggested that there might be new ways forward. When we achieved funding to work with NERC Institutes on spatial analysis of soil pollution, and with the Health Protection Agency on providing high levels of hygiene control under operating theatre conditions, the door to a brave new world fleetingly opened.

The beginning of the end for the Institute was signalled by a BBSRC review, chaired by Professor Sir Brian Follett. His reputation for hard hitting reviews preceded him, and few are likely to have been surprised that his conclusions challenged the continuing separate existence of the Institute. However, the recommendation of his review team was not for the work to close down, but that SRI should cease to be a free-standing BBSRC-sponsored Institute and that its core activities should be merged with those of a complementary institution.

This turned out to be a false dawn – the challenges of transferring up to 200 staff to another organisation would always have been considerable, but were especially so at that time, with Defra funding threatened by the financial aftermath of Foot and Mouth, and BBSRC funding to any non-Institute successor body also uncertain. For a short time a privatised research company endeavoured to make a convincing case but to no avail. Since no suitors were to be found, the Research Council, now seeing itself as an honest broker rather than a decision-maker, accepted closure as the only option and a plan to close the Institute in March 2006 was put in place.

Despite the upheaval and disruption of the closure, efforts by many individuals and small groups ensured that key pieces of science and technology found new homes – at Rothamsted Research (a BBSRC Institute just 15 miles away in Harpenden), the Royal Veterinary College, Cranfield University, The Arable Group and the University of Birmingham. The latter two organisations, together with around five start-up businesses, were able to secure accommodation and facilities on the Wrest Park site whilst several other scientists started up their own consultancy services elsewhere. Thus some of the engineering skills and scientific expertise developed and nurtured at Wrest Park for over half a century continue, for the time being, to contribute to the benefit and improvement of agriculture, food and the environment in the UK and overseas.

This story paints a picture of the Institute itself, but its closure should be seen in the context of changes in agricultural engineering on a broader front in the UK. The number of universities awarding undergraduate degrees in agricultural engineering had dwindled to just two by the turn of the millennium and soon after only Harper Adams University College was left. This fragmented base is a challenge to the sector – sustaining skills and expertise to create innovation for the industry will not be easy!