NEWSLETTER

RETIRED CHARTERED ENGINEERS ASSOCIATION
WORTHING

Hon. Secretary: S. Oliver. Elphin, North Drive, Angmering, BN16 4JJ ☎ 01903 787116

FORTHCOMING EVENTS

17th to 21st May		**Spring Break** to France, cancelled through lack of support
8th June	Tuesday	**Outing** to Fishbourne Roman Palace see pages 9 & 11 for details and signing up
13th July	Tuesday	**Outing** to Weald and Downland open air museum, Singleton see pages 9 & 11 for details and signing up
3rd August	Tuesday	Committee meeting 2.15 p.m. at Field Place
10th August	Tuesday	**Outing** to Tangmere Military Aviation Museum see page 9

Coffee Mornings

Laing's Arcade Cafe, Montague Street, Worthing.	Every Monday
Albion Inn, 110 Church Road, Hove.	First Wednesday of the month 7 Apr, 5 May, 2 Jun, 7 Jul, 4 Aug
The Spotted Cow, Angmering	Third Thursday of the month 15 Apr, 20 May, 17 Jun, 15 Jul, 19 Aug
Beach Hotel, Worthing (with Ladies)	Last Thursday of the month 29 Apr, 27 May, 24 Jun, 29 Jul, 26 Aug

Coffee mornings commence at 10.30 a.m., except at The Beach, which is from 10.45 a.m.

Copy date for next Newsletter 9 Aug

Membership

We welcome the following new members:

1999 **JARRETT, Eur.Ing. G.S.H.** B.Sc.(Eng.) A.I.Mech.E., F.I.E.E., *26 Gilhams Avenue, Banstead, Surrey, SM7 1QR (0181 3933090)* H.M. Dockyard Sheerness, draughtsman 1940-46 C.E.G.B. S.E. Region 1947-81, transmission, design & construction manager. Part time lecturer Wandsworth Tech. Coll. *Interests:* Gardening, DIY, Bowls,Woodworking, Cricket, Probus, Classical music, Model railways.	1999 **PUTLAND, F.A.** M.I.Mech.E., 5 The Driveway, Shoreham by Sea BN43 5GG *(01273 464788)* Ricardo Consulting Engineers, Shoreham. R&D Diesel engine tester 1955-63 Instrumentation engineer 1963-91 Part time consultant on engine instrumentation at Ricardo and Engineering School of Sussex University *Interests:* Wine making, Gardening, Photography, Folk music and dancing, DIY, Walking

We reget to announce the death of H.B. Bailey in January and his wife a week later. To date we have 113 members.

Visit to Pirelli submarine cable works, Southampton on Tuesday, 12th.January 1999

Eleven members, including some new members, visited the Pirelli submarine cable works on the afternoon of the 12th.January 1999. Unfortunately our President could not been with us he had intended. He missed a very interesting visit.

The Manufacturing Manager for the submarine cable works, Mr. Adrian Perrett, started the visit with a review of the wide range of power and composite cables produced at the factory. Impregnated solid and oil filled paper cable cores are produced at the factory but EPR (Ethylene propylene rubber); XLPE (Cross-linked polyethylene) and other cores are manufactured elsewhere. These include optical fibres, hydraulic pipes and other services particularly for offshore oil platforms. Paper cables and other cables including XLPE are lead sheathed but EPR cables are generally of the wet type (i.e. an impervious layer is not required). Various outer layers of PVC, polyethylene, single and double wire armour, polypropylene strand, bitumen and various bedding layers can be applied as required. Mounted samples of the cables produced at the factory were available for our inspection that included the cross channel +/-270kV, 900mm 2 dc cables with solid paper insulation. The factory was, initially, built to meet Pirelli's contract for part of the cables required for the cross channel link. It is capable of producing cable in long lengths in order to avoid the use of any type of joint undersea, the ultimate limitation being the weight, which can be handled by the largest cable laying ship.

Mr. Perrett and a member of his staff escorted us around the works in two groups starting with the line of machines for laying up segmental copper conductors, which are first run through a cleaning trough. There is also provision for pressure butt welding and dressing joints in the individual strands to make the long continuous lengths required for submarine cables. The completed conductor is then loaded on to a turntable pending the next stage of applying the paper insulation which is carried out on a line of machines enclosed in a clean room with a controlled atmosphere to ensure that the paper is kept clean and dry. The wrapping machines require careful setting up and running to ensure that each paper follows the required helix so that the gap between turns is kept to a minimum with no overlapping. Each layer is staggered to so that gaps do not coincide. Each machine takes up to 12 layers of paper tape and about 30 machine are available to provide the number of layers to complete the insulation which includes the initial and final semi-conducting layers. The

paper thickness is of the order of 20 microns but this does vary according to the insulation design. The large number of layers required indicates that the line of machines has to be stopped frequently as the rolls of paper are used up. This requires careful control of the rotation of the machines, and of the associated tractor units traversing the cable, to ensure that the papers are not disturbed. The insulated conductor passes out of the enclosure in a tube and is fed into the rotating synthetic oil bath. After the run is completed the lid of the oil tank is clamped down and the impregnation of the insulation is carried out under vacuum and heat. After impregnation the cable is unwound from the oil bath and is passed down a tube to the lead press for applying the sheath. Oil is circulated around the cable to ensure that the paper is not exposed after impregnation. The sheathed cable is run on to a turntable and, in the case of oil filled cables, it is coupled to oil pressure tanks to maintain a positive pressure within the cable. The next and final stages include wrapping non-magnetic reinforcing tape (bronze or stainless steel for oil filled cables), extruding PVC or polyethylene sheaths, wrapping bedding tapes, laying outer conductors, armouring, application of bitumen, wrapping polypropylene yarn serving etc. depending on the construction of the completed cable. Prior to these stages, in the case of three core cables and composite cables, the cores and other components are assembled in the vicinity of the laying up machine. This is a vertical machine and the cores etc are guided into the top of the machine as the completed layed up cable is rotated and fed down on to a turntable. The laying up and final stages can also handle EPR and XLPE cores. The lines of machines are laid out in parallel rows so that the cables pass up and down the factory with the various turntables at each end to store the cables between the stages. Finally the completed cable is taken out of the factory on a overhead gantry to the final laying down store which is designed to take up to 8000t. From this store another overhead gantry takes the cable to the dockside for loading into the laying ship.

The impression of the works is of high flexibility required to produce a wide variety of cables and of the great care taken to ensure that the quality of the cable is of the highest order as is necessary for submarine cables in view of their inaccessibility and the costs involved in their repair.

A well worth while visit in spite of the greater travelling distance compared with most of our visits.

Geof Picken

Aircraft Systems – the Harrier Destiny - Talk by J. Apted, member, at Field Place, on 9th March, 1999.

This talk was labelled "Aircraft Systems" because when, on the spur of the moment, I was asked to say something it was the subject which occupied the greater part of my working life in the Hawker Design Office. To be clear about the term "systems" I mean the engineering of the internal fluid and mechanical services; e.g. fuel, hydraulic, gaseous, cooling, heating and pressurisation, flying controls, engine installation, are just some of them. This, however, came to an end more than fourteen years ago and so anything I say about its technology now should be regarded as strictly historical (and perhaps a touch nostalgic).

The Harrier was one of the major projects that came to fruition during this time and as a concept has been going for 40 years with an operational service time of 30 years. I wonder whether that surprises you as much as it does me when I reflect on the turns of fate on which it all began. That is why I have chosen the title "Harrier Destiny" although I did also consider Harrier Dynasty. I am sorry if this talk has already become Harrier biased with a "dream time" aspect, but to me it was an absorbing career path. I'll try to compensate with a few system details as we go along within the limits of my memory.

I'll just remind you that members of this Harrier Dynasty are operating all over the world on land and sea, not with just the Royal navy, but with the U.S. Marine Corps, the Spanish Navy, the Italian Navy and the Indian Navy. With the R.A.F. they were many years in Germany, some time in Belize, accompanied the Navy to the Falklands and have been in many shorter tasks worldwide. The family tree illustrates the variety of types in both single and two seater versions. The currency earnings for the production aircraft and for spares and facilities, including training of air crew and ground crew, must be enormous.

But the value to this country has not only been monetary; it has been a means of having a viable military presence wherever it was needed. No more certain case for this capability was in the Falklands when the entire operation could have been a disaster without their protective air cover. Many commentators, including those taking part, have said that without the Harrier it would not have been possible. In the foreward to a book in which a series of personal accounts are given the overall Commander in Chief, Admiral Lord Lewin, says "How lucky we were to have the Harrier because there is no doubt that without it there would have been no possibility of responding to the unprovoked invasion of the islands."

The choice of the word "lucky" in relation to an issue of national defence is surprising but a strong element of luck has been a part of Harrier existence from the beginning. I hope in this talk that some of the other essential elements in its progress will appear.

From the mid 1950's onwards there was great enthusiasm in Europe, America and Russia to produce aircraft that could lift off vertically, i.e. by direct jet lift or ducted fans rather than rotating helicopter blades. In the U.K. this was led by Rolls Royce with small specialised high thrust to weight ratio units as in the Short S.C.1 aircraft. By the date of this publication in 1969 there were 22 listed in this category including the first Harriers, which were about to enter service with the R.A.F. The development story of the Harrier may be familiar to you but it needs some repetition to appreciate the features by which it became the only project of the group to go into 30 years of service.

The idea for an engine in which the thrust could be redirected between the horizontal and vertical began in France after the war and before Hawkers were involved. It came from a Frenchman named Wibault who spent the war years in the U.S.A. and had gained good contacts there. His scheme consisted of four large volute casings of centrifugal blowers, two on each side with a turbo-prop engine in between to provide the power to drive them through shafts and gears. The volute casings were to be rotatable to direct the airflow vertically down or horizontally aft.

The term "Vectored thrust" was coined by Von Karman in the U.S.A. and it was American money in the form of a Mutual Weapons Development Programme that supported the study in the early days. Rolls Royce in the U.K. were more interested in separate specialised lift engines, e.g. The "Bedstead" and the Short S.C.1.

The Bristol Aero Engine Co. became involved with M.W.D.P. at American invitation and enquired around for an interested U.K. airframe builder for further advice. The Bristol concept of the engine at this stage consisted of a two stage turbo-fan with a rotatable elbow nozzle on each side, driven by a coaxial turbo jet with a fixed aft facing nozzle, designated B.E.53.

A copy of the engine brochure came to rest in the then Hawker Project Office via the Chief Designer, Sir Sydney Camm, and it was then that ideas began to take shape for an airframe. This was in 1957 (over 40 years ago) when at the same time Hawkers were putting considerable design effort into a supersonic successor for the Hunter. Work on a V.T.O. development proposal was hardly a main line task for the Kingston team, which by tradition were the providers of high performance fighters or strike planes which extended the bounds of technology but did not open new chapters.

Faltering progress on the supersonic project (P.1121) made the V.T.O. project an interesting diversion, a relief of frustration and an opportunity for inventive thinking for a few people who could spare the time from the main task. The exchange of ideas between the airframe and engine teams led to a further transformation of the engine into a configuration of four rotatable nozzles and two contra-rotating engine spools with a single air intake. This format, eventually named Pegasus, has remained the same but with many internal improvements which have doubled the thrust rating throughout the ensuing 40 years.

My first contact with the project came in 1958 when a model was required to measure ground effect forces. (An effect on the airframe which could not be readily calculated due to the entrainment of airflow into the engine jet columns and the ground sheet flow.) By this time a definitive prototype form had evolved which had a layout and format essentially the same down to the present day aircraft.

The model was simply a 1/16th scale wooden carving painted with matt black. It was supported in a "Dexion" gantry frame rig over a variable height ground board. Jet flows were simulated with a high flow of compressed air to a set of four nozzle udder fed from a large duct above the model. Small clearances between the model and jet assembly allowed small forces on the model form to be measured without the intrusion of much greater nozzle forces. Surface flow patterns on the ground and model could alto be explored with this facility.

My involvement at this point was due to the fact that I was in charge of a small group doing air systems testing on the Hunter cabin pressurisation and air conditioning systems.

The 1/16th scale model was quite soon superseded by a more sophisticated 1/10th scale with a heated air supply and a wider range of uses.

Other model tests were done in the wind tunnels at R.A.E. free of charge, but all the design costs on the airframe were carried by Hawkers until mid 1959 while the engine development was 75% funded by the American M.W.D.E. and the rest by Bristols. All work on supersonic projects at Kingston then stopped when the TSR2 requirement went to English Electric, which left the Kingston design team able and glad to start issuing manufacturing drawings. In spite of a lack of enthusiasm from official sources, the first prototype of the two that had been authorised went to the airfield at Dunsfold in July 1960; it was a remarkable effort by all concerned, especially as the contract for their construction had only been signed three weeks earlier.

This point could be regarded as the birth of the Harrier concept although the aircraft was still only an untried experimental idea with the designation P.1127. It is worth noting at this time some of the unusual and surprising features of the aircraft which have persisted throughout the family line which became the Harrier.

First the two spool (contra rotating) by-pass type enginee feeding four separate jet nozzles through which the engine thrust can be rotated through 98 degrees.

The unusually high anhedral or droop appearance of the wings. Further, the one piece construction of the wing, which must be removed for engine change.

The unique bicycle type undercarriage with outrigger wheels.

Rather large semicircular air intakes (Elephant ears). A total of six controllable air jet nozzles linked to the aerodynamic control surfaces for hover control. These are fed internally by ducting connected to the engine carrying air which can reach a pressure of 200 psi and 400 deg C with an intermittent flow up to 121b/sec. (say 10,000 cu. ft. per minute at standard atmospheric conditions).

A 50 gallon water tank in the fuselage behind the engine for engine cooling water injection.

These are just some of the more noticeable features which characterise the breed over this 40 year span and represent a milestone in its evolution as a V.T.O.L. aircraft.

The next phase of life from 1960 was one of learning and growing into an aircraft with a genuine operational capability that was seen to be needed by the armed forces in the U.K. and U.S.A. It took something like 8 years for this to happen with alternating successes and frustations. The technology made steady progress but belief in it for operational purposes was slow to develop. In this period the first two prototypes were followed by four more, which allowed an extensive development programme to explore and demonstrate the unique capability of this strange new breed of aircraft. At the same time, however, the Services were pressing for much higher performance projects to be studied with the issue of a series of demanding "Operational Requirements". N.A.T.O. also joined in this activity with the issue of their NBMR-3 requirement resulting in an international competition between manufacturers in several different countries. Much time and effort was spent over several years on project proposals and brochuremanship leading to the H.S.A. P.1154 which was judged to be a joint winner. This overshadowed and retarded P.1127 work. There were no prizes, however, and it all came to an end by government edict ahead of the TSR.2 cancellation.

By this time, however, the P.1127 prototype had gained a band of enthusiasts who saw a future in VSTOL operations and out of the mire came proposals for a "Tripartite Evaluation Squadron", jointly financed by Britain, U.S.A. and Germany. This led to an improved version of the prototype aircraft named the Kestrel with many of the lessons learnt on the prototypes embodied. Nine were built for extensive joint testing of the military potential by the three Nations. Bristols were able to provide an uprated engine and various aerodynamic and airframe improvements were added. It was a highly successful trial for pilots from three N.A.T.O. allies and demonstrated a valuable operational capability from dispersed and improvised sites close to ground forces. It also provided a degree of continuity for the Company when all other new aircraft projects in the U.K. had been cancelled. The enthusiasm and promise of VSTOL contrasted with the lack of any further development at the conclusion of these trials, and to avoid possible embarrassment the government authorised the construction of two further aircraft to meet an R.A.F. specification requirement labelled P.1127 (R.A.F.). This later became a batch of six pre-production development aircraft and an indication that the R.A.F. would want a total of 60 for squadron service. A challenging time scale and a comprehensive avionic and weapons fit was presented to the Company, but the order to build was short on official commitment and many doubters were gloomy about its usefulness. There remained a core of enthusiasts for the aircraft especially among those who had flown it, and the teams at Kingston and Dunsfold worked hard to meet production and test programmes which led to it being ready to enter service with the R.A.F. in April 1969. Apart from its VSTOL capability it was required to be able to operate away from main bases with the minimum of ground support. In an extreme case it was proposed that it would land in a battle area with no ground facilities, fully

loaded with stores, and remain on standby for a number of hours. (Taxi rank operation I think it was called.) It incorporated a self starting gas turbine starter combined with auxiliary power unit, which could run continuously or at intervals to recharge the battery and maintain radio and navigational equipment functioning. An extended duration liquid oxygen system was developed for life support at high altitude and ground handling was improved with sensitive nose wheel steering, main leg shortening and state of the art braking system. A great variety of design, development and test work in the fields of fuel system, hydraulics, flying controls, reaction controls, engine nozzle control, life support and escape, air conditioning, engine installation, etc., etc. was an enormous challenge for a mechanical engineer in an airframe environment.

Intensive development programmes were compiled to cover all aspects of Service acceptance in relation to performance, serviceability and life expectancy in conjunction with A. & A.E.E. Boscombe Down in Sicily, Arizona and Canada and extensive U.K. trials on the Nav./attack and weapons delivery systems. It was clearly understood by the teams involved that any lack of: success gave an excuse for project cancellation. The industry was continuously under threat of changing project requirements, Nationalisation and Redundundancy, loss of manpower to the U.S.A.; that gloom continued to accompany success all the way to delivery into service.

This was the point when Harrier fortunes changed for the better, that is when the first R.A.F. squadron was formed and they began to appreciate what the aircraft could do. At about the same time there was a sudden surge of interest from the U.S. Marine Corps, who had watched but not taken part in the tripartite trials, with talk of a requirement for over 100 aircraft. In the circumstances it seemed beyond the bounds of reality. The complexities of the American procurement procedure and possibility of them buying foreign military aircraft were too much to take seriously at first hearing. The Marines were so keen, however, that it was the aircraft they had wanted since the Korean War that they succeeded in short circuiting the system to order a first small batch to the R.A.F. standard. This story needs to be told separately and has been well documented in the Bruce Myles book "Jump Jet" It was inconceivable to many Americans too, but for the Harrier it was the key to the future in so many ways.

Extract from book of Congressional and Senate budget hearings of May 1969, pages 144-5.

"Yes it is not without good precedent that where the British have concentrated and worked hard, they have come up with things that we have not. After all Pratt and Whitney would not be developing the turbojet and turbofan to day if they had not had a licence from Rolls Royce in the beginning and learned to build it. General Motors, as big as it is and as great as it is, and with its Allison Division going back so many years, in order to get back into the jet engine business, had to become a licencee for the TF41 and other Rolls Royce engines.

I know that you're aware that the British in their own way came up with the steam catapult, the angled deck and the mirror landing system. While we were so busy moving our carriers around the ocean, into the Mediterranean and out West, they, without funds and striving and struggling, did come up with these concepts, as they have with some other things. They have concentrated on this type of airplane.

It does hurt a little to realize that these people have come up with something's that we couldn't, but we would spend millions of dollars and much time going back to Ryan or anybody else to do it now. It seems to me it would be a great waste. We have put so much into Britain. We have helped them for a long time, as you well know. This (the Harrier) is something that they have, and it does seem to me that that island over there would be a liability to us if they didn't stand on their own two feet. This (aircraft) and the engine are the only things I know of that they have come up with in a long time."

Although at this point the Harrier's struggle for survival had been successful, there were several further milestones that can be put in the record briefly –

1. Two seater version (early 1968).
2. The Trans-atlantic air race (May 1969).
3. Licence partnership with Mcdonrlell Douglas Corpn.
4. Royal Navy Sea Harrier leading to navy retention of fixed wing jets and the ski-jump carriers.
5. Development of thrust vectoring in forward flight (VIFE).
6. Super Harrier or AV8B, Harrier II. (Development jointly by M.C.D. and B.Ae.)

My conclusion to this story (maybe a little biased) is that the Harrier is one of themost significant aircraft engineering achievements since flight began at the beginning of the century, and I hope you will ageee that the Hawker Kingston Design story is one of the most successful in British Aviation.

One final ironic comment:- By chance the R.Ae.S. Journal of last November carried a report on the J.S.F. Study (Joint Strike Fighter or the next generation of VSTOL aircraft for Harrier replacement). To introduce the article the front cover carried the words: - "Perfecting a jet fighter which can hover in ground effect is no mean feat of aeronautical engineering. Much research is being done to understand this complex aerodynamic environment."

John Apted

Visit to Daewoo, Lyons Park, Worthing on Tuesday, 16th March, 1999 at 2.30 p.m.

Members visited the Daewoo Motor Company's Worthing Technical Centre (DWTC) and enjoyed a most interesting insight into a rather surprising and impressive operation, in a quiet corner of Worthing, hidden behind a couple of superstores.

Our main host, Les Walker, opened the visit by describing the Daewoo Group and the role of DWTC in its operations. The Group is South Korean owned, founded in 1961, the founder "Mr." Woo still being the President. It has thirty-one manufacturing plants worldwide and employs some 320,000 people. The Group is involved in a wide range of activities, including engineering, ship building, electronics, domestic appliances, construction, hotels and property, as well as motor vehicles.

The motor vehicle activities were commenced in 1991 as Licencees of General Motors, who held a 50% stake in the Daewoo Motor Company until they were bought out by Daewoo in 1994. At the same time, Daewoo purchased the ailing Worthing-based International Automotive Design (IAD) Company, a substantial design consultancy with operations in several countries. About 170 IAD employees transferred to Daewoo. Daewoo now employs over 1,000 staff in Worthing.

To-day, Daewoo is a major player in motor vehicles, building cars, vans and light trucks and has the aim of being in the world's top ten for annual output by 2001. In order to achieve this, they are concentrating on the developing world and have manufacturing plants, besides in South Korea, in China, Vietnam, the Philippines, India, Iran, Uzbekistan, the Czech Republic, Poland and Tunisia. In the UK they have recently purchased LDV, the van and light truck operation in the Midlands, which is the surviving rump of the Leyland and DAF goods vehicle builders. The major design centre is in South Korea, with major inputs, including the complete design of some vehicles, at DWTC, who work on everything except engines. Daewoo's main engine development centre is in Germany (GTC) but a lot of work is carried out by Ricardo at Shoreham. Close ties are maintained with General Motors, who are still a major source of components. In addition to design, DWTC manufactures prototype vehicles for evaluation and test. These are built by hand and can cost up to £300,000 each. For a new model which is going into production, up to 80 vehicles are built, to cover all the needs of prototype testing and build procedures including, of course, the very rigorous crash testing regimes of the various countries into which the vehicles are to be sold.

After the introduction, we found the Design Office and were given demonstrations of various design aspects of vehicles. Almost all design is computer generated, but some drawing is still used in the Styling Studio. We were then shown the Computer Centre and Computer Help Desk, where the storage of data and data dissemination was discussed. As in the whole of the world's motor industry, the working language is English.

From the intellectual side we moved to the practical, where we saw the Final Build Centre, but were excluded from the final prototype shop, where vehicles two generations into the future were being styled. In this centre, vehicles are formed first as clay models, right up to the completed vehicles for test and evaluation. Like all their competitors, Daewoo also take other makers' cars to pieces to see what they are doing.

The visit concluded with a tour of what was the I.A.D. site in Dominion Way, where we were shown round the prototype body building shop and the test laboratory. Work in the former was on vans intended to be manufactured in the Czech Republic. Perhaps the most startling demonstration in the Test Lab was that where Daewoo's new (and wholly Worthing designed) mini car, the Mutiz, was being subjected to a static test on a rig simulating Belgian pavé – a shaking far worse than any fairground ride – but an eye-opener to those interested in cycle racing. The annual early season classic bicycle race from Paris to Roubaix purposely traverses long stretches of pavé!

During the introduction to our visit, Nabil Haridar, Manager of the Simulation and Integration Group in the Design Department, and a committee member of the South Eastern Branch of the I. Mech.E. spoke of the institution involvement at Daewoo. Over 100 members of the I.Mech.E. are employed at DWTC and the company pays their membership fees. Continuing Professional Development is very much encouraged, both for new entrants aiming at Chartered status, and for those who are already Chartered. The company also runs a relatively traditional craft apprenticeship scheme, taking nine or ten apprentices each year for a four-year course. Even though these are well advertised, they often have fewer applicants than they have places – for which they blame the schools!

Altogether a very worthwhile and enjoyable afternoon for all of us.

Richard Norton

Outing with partners to Fishbourne Roman Palace, on Tuesday 8th June, 1999 at 2.30 p.m.

Fisbourne's impressive remains came to light in 1960 when a new water main cut into the previously unsuspected foundations and mosaics. It was to prove one of the most important British archaeological discoveries of the century.

Over the next nine years archaeologists uncovered a military supply base established at the time of the Roman invasion in AD43, along with later civilian buildings. The sumptuous palace itself was constructed around AD75, possibly for a Celtic king, Tiberius Claudius Cogidubnus, and rivalled in size the imperial palaces of Rome.

Fishbourne's superb Roman garden has been replanted to its original plan, based on the bedding trenches, tree pits and post holes that survived centuries of ploughing. A new area displaying the plants grown by the Romans has been created and stands alongside the Roman Garden Museum featuring gardens from Britain and Italy. A Roman 'potting shed' displays a range of replica horticultural tools and equipment as well as original implements found on the site. Archaeological excavations continue and in 1996 and 1997 the remains of a large building were uncovered that may be military headquarters.

There is a spacious picnic area and a cafeteria providing a good range of hot and cold meals.

The entry cost per person will be £3.40.

Closing date for applications 25th May, 1999 - please return form on page 11.

Outing with partners to the Weald and Downland Museum, Singleton, on Tuesday 13th July 1999.

The open air museum at Singleton is probably well know to members but, if you have not visited it for some time, it will be well worth another visit. Several buildings and facilities have been added in recent years. One old cottage is under re-erection at the moment and will be finished by July, whilst a new conservation and store building of unusual "grid-shell" construction may be underway by July. If you have not been before, you are can be assured that a visit is well worthwhile.

We meet at 12.30 p.m. at the entrance to the museum, before taking advantage of the museum's Egon Ronay recommended café, offering light hot and cold lunches and snacks. This has outdoor and indoor seating and is self-serving. A guided tour of approximately 1 1/2-2 hours has been arranged to start at 2.30 p.m. for a maximum of 25 people.

The cost per person is £5 to cover the party entrance fee and the guided tour only.

Closing date for applications 28th. May 1999 - please return form on page 11.

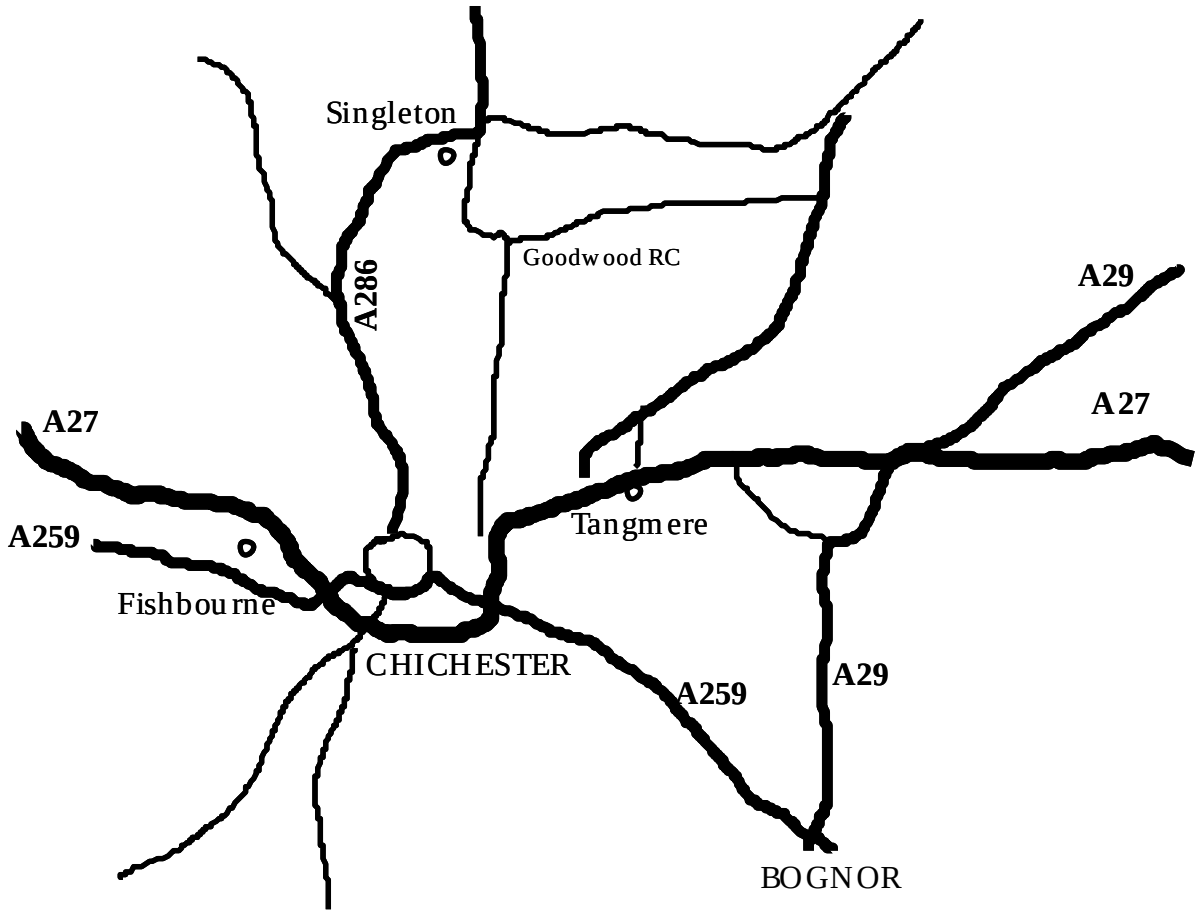
Outing with partners to Tangmere Aviation Museum, on Tuesday 10th August 1999 at 2.30 p.m.

The Museum contains a wide variety of exhibits relating to seventy years of military aviation in Sussex. There is a cafeteria and picnic area at the museum. Admission fee to the museum is £2.50.

A pub lunch is being arranged in the area, details will be finalised nearer the date. If you would like to meet up for a pub lunch at 12.00 noon, please telephone Brian Haynes on 01903 774 914 by 27th July.

Hampton Court Flower Show

Rustington National Trust Centre has a coach outing to this event on Thursday, 8th July. For further details, telephone Stan Renew, on 01903 785891



Fishbourne Roman Palace

The museum is sited to the north of the A259, off Salthill Road, signed from Fishbourne village.

Tangmere Military Aviation Museum

The museum is signposted from the A27, three miles east of Chichester

Please note that no confirmation of your application will be made and no tickets will be issued. However if there are any problems, eg there is a waiting list, then you will be notified.

To S.M. Butler, 250 Harbour Way, Shoreham, BN43 5HZ Tel: 01273 464527

I wish to participate in the outing to **Fishbourne Roman Palace** on Tuesday, 8th June, 1999.

Full Name .....(Block capitals)

Address .....

.....

Phone No..... **Applications by 25th May, 1999**

Number of persons..... Cheque payable to RCEA at £3.40 per person enclosed

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To: G.H. Picken, 2 Fairfox Cottages, Fairfox Lane, Henfield, BN5 9PD Tel: 01273 493600

I wish to participate in the outing to **Weald and Downland Museum** on Tuesday, 13th July, 1999.

Full Name .....(Block capitals)

Address .....

.....

Phone No..... **Applications by 28th May, 1999**

Number of persons..... Cheque payable to RCEA at £5 per person enclosed