Alan Windle

Response to a toast on occasion of reaching 80

Dinner in Hall, 31st October 2022.

Thank you Vice Master for your kind words, and to everybody here for drinking my health. Thank you also to all the staff who prepared the excellent meal, something they do for us, day-in, day-out. We are extremely grateful to you all

It seems a tradition, almost, that Fellows in responding to this toast say something of their early lives, and do not dwell over much on their research careers, most of which will already be in the public domain. I hope I have got the balance right.

Early Years

My paternal great grandfather left farming in Derbyshire to go to Spain to build the first ever railway there from Barcelona up the coast to Mataro. On his return to the UK he married Mary-Ann Hardwick from his hometown of Heath in the environs of Hardwick Hall in Derbyshire, and it is from my Great Grandmother that I inherited my middle name, Hardwick. He then moved to London working for the borough of Marylebone, with particular responsibilities for drainage, luxuriating in the grand title of “Inspector of Nuisances”. For the subsequent generation, both my grandfathers were London shop keepers, one a grocer, the other a fishmonger.

I was born in Croydon in the depths of the second world war. Shortly before my birth our house had received a fire bomb courtesy of the German Airforce, which burnt out the kitchen. I have a few memories of the war when it was nearly at an end. We had a Morrison Shelter, a steel affair with a 1/8” steel plate as a roof, which more or less replaced the dining room table, the idea being that if the house came down as a result of a near miss, then one could be dug out from

inside it, intact. I have occasional early memories of eating in our shelter, and I guess I slept there as well. However, probably my most vivid memory was when I was out walking with my mother. The siren went with its special 'take cover' wail, and we had to a hurry towards a public shelter on the street. However she then stopped and grabbed me to her, I remember most clearly her mixture of excitement and fear, as she pointed to the sky where something went over. This was a V1, a pilotless plane with a 1 ton warhead, in fact one of Hitler's revenge weapons which we called flying bombs or doodle bugs, and today would be understood as cruise missiles.

Amongst my father's papers I found a map of V1 bomb explosions in Croydon. (Fig 1) It was published prematurely in 1944 when everybody thought the risk of flying bombs was over as the fixed launch sites in France had been overrun by the allied forces. However, the attacks continued for another 6 months from the East, with some of the missiles being launched from Heinkel bombers over the North Sea. It must have been one of these later attacks that I remember.

School Days

I was an only child, but fortunate to have parents who not only gave me a wonderfully happy home, but believed passionately in education. They had bought a semi-detached house near Croydon, and that must have meant that they were crossing the divide reaching for the bottom rung of the Middle Classes. My mother went out to work, almost unique on our street, so I could be sent to Whitgift School in S. Croydon, founded incidentally by the will of John Whitgift, Archbishop of Canterbury, who earlier in 1567 had become the 6th Master of Trinity. Whitgift was a public day school with fees of £25 per term, but they gave me some sort of grant which enabled my parents to afford to send me there. We were taught well by a mainly Oxbridge educated staff. The school also had an excellent Combined Cadet Force (CCF), possibly because about half of the masters who ran it had seen active service in the war. It was discovered that I could shoot straight and I was in the first VIII at inter school competitions at Bisley

for four years, mingling there with teams from about 100 other schools, shooting throughout the day under identical conditions.

In summers we practised on open ranges, often away in the countryside, getting there by coach. On occasions when the coach was due to pass my house, I was given permission to take my rifle home the night before. So to get home as usual, I would climb up onto the top deck of the No.194 bus, with my .303 match rifle slung over my shoulder and my shooting box containing live ammunition in my other hand. I was not in CCF uniform but probably had a school blazer on. Nobody batted an eyelid. Times were different then.

In the science sixth form, we had interviews with the senior master, which afterwards I realised were to separate the sheep from the goats regarding those who would join the Oxbridge entry set and stay on an extra term. The master, whom I never got on with particularly well, had all my records in front of him, and perhaps some of the more recent numbers indicated that I might be selected. However, something was worrying him and I suspect now that it was a resurgence of the ' social class thing', nobody in my family having ever been to University, so was I the right type to go to his old University? However, he then spotted that I had done really well in the lower forms at wood work and metal work and he seized on that. He said that as I was really good with my hands I should go into industry as an apprentice, and perhaps do a degree later. This disappointment sent me to the cupboard that was then the careers room, and I came across some fascinating glossies from the steel industry. I then discovered that one could study Metallurgy at University, and more than so, at Imperial College, S. Kensington. I knew the South Ken area well as I used to take myself up to the Science Museum at week ends working my way through the galleries bit by bit. So despite my schoolmaster's advice, I applied to Imperial and was accepted with a conditional offer.

The sadness at this time was that my mother, who had given me so very much, died suddenly just a few weeks before my A levels.

Imperial College and Cambridge for PhD

At Imperial, I was hugely fortunate, in that Metallurgy had just developed from a practical art into a science, driven forward by a bunch of brilliant physicists and chemists. I enjoyed the course and thrived, so a PhD beckoned. In fact, it wasn't quite that straight-forward. As an undergraduate I had joined the University Air Squadron, a part of the RAF. I loved flying, and had the special experience of being taught by an ex wartime spitfire pilot. So as my course was drawing to an end it was really a toss up between doing a PhD or joining the RAF. It was really that close. It is probably good that at the time, the immensity of the decision weighed on me not a bit. Then one day I saw on the Imperial College noticeboard, a letter from Trinity College Cambridge advertising a research studentship. At the time I was impressed by the quality of the notepaper and that the printed address at the top was simply Trinity College, Cambridge. So I decided that if I got that studentship, I would go for a PhD rather than join the RAF. I applied and heard nothing for weeks and weeks. Meantime I had been accepted by the Metallurgy department here at Cambridge, then under the leadership of Alan Cottrell. Eventually I heard back from Trinity that I had been unsuccessful, with the sentence I will always remember being "the competition had been unusually severe this year". Somebody had bothered to say that, which was nice. However, the letter went on, that as I had alternative funding from the department, I could certainly come to Trinity as a PhD student.

My first sight of Trinity, ever, was walking through Great Gate and seeing Great Court. It took my breath away, somehow the way the court was just that bit below my vantage point had something to do with it, coupled of course with the scale. Trinity's beauty still takes my breath away, especially in particular lights.

I loved doing science for my PhD, which was quite experimentally intensive. It was a study of what happens to the properties of nickel when one dissolves hydrogen in it.

Back at Imperial

Post PhD, I decided to give myself another couple of years of University research enjoyment before fulfilling my destiny in Industry. This was enabled by an ICI Fellowship back at Imperial.

The research, involving looking at atomic dislocations in ultra pure copper single crystals, moved ahead, but I was being asked, increasingly, to undertake teaching. Amongst other such duties I was lecturing a graduate course to mechanical engineers. So I went to my professor, to tell him of this time conflict. His answer was that under the terms of the Fellowship, I did not need to do any teaching at all, or alternatively, I could join the Department, "I will send you some information", he said. Two days later I received a bundle of papers which seem to be offering a lectureship. I took them home to my father, who nearly fell off his chair with the words, that this is a contract for life - (they were then) – and that I should accept it immediately (I did)

So by chance, by accident even, I found I had become an academic, rather than an industrial scientist.

It was at Imperial that I learnt my academic trade. Lecturing, tutorials, interviewing, examining - and so on. However, I had also by then, written up my Cambridge PhD work for publication and off went the first paper to a leading metallurgical journal. It came back with a flat rejection. Both referees had focused on a relative minor part of the paper where, from mechanical properties, we had predicted what is known as the stacking fault energy of nickel. However, on looking at the reports, one referee said my value was far too high, and the other

that it was far too low. The editor had not noticed this stark disagreement, and had seen it as a double whammy against the paper.

Somehow this exchange so dented my confidence in the professional metallurgical journals of the time, that I decided I would move away from metals into polymers, which were now becoming *de rigueur* as 'Metallurgy' morphed into 'Materials Science' as the taught discipline. I persuaded the Imperial department to allow me to spend a year working under Andrew Keller and Charles Frank in the Physics department at Bristol on the structure of crystalline polyethylene. I was buoyed up by the intellectual demands of that department in its heyday. As someone said: "physics was in the air we breathed".

Subsequently, while, back at Imperial, I had met and married Janet, the love of my life, and 3 of our 4 children were born. Janet was the home-maker, for not only was the academic life demanding of time, even then, but I had to spend nearly 3 hours a day commuting to Imperial from our home in Surrey. As always when forging a career, ones involvement in family life falls short of the ideal, but I don't think the children missed me too much, and perhaps it is some solace that two of my daughters, both here tonight, ended up married to academics.

Back to Cambridge and Trinity

In 1975 an opportunity to move to Cambridge emerged with an advertised lectureship in the Metallurgy department. I was offered the post and we moved here, managing to buy a house within a 20 minute walk of the city centre. Some two or three years supervising for Trinity seemed to pave the way to a Fellowship. I was the first teaching Fellow ever to be elected in my subject, and I was delighted that Trinity decided to name the College Lectureship as being in 'Materials Science', rather than in 'Metallurgy'.

My first ever lunch in Hall was memorable, for the wrong reason. I think the collection of the food was reasonably obvious but where to sit? Eventually it

became clear that I had to spot the 'growth front' of Fellows as they added themselves to the high table. I did this only to discover that I had sat next to the then Master, RAB Butler, who had admitted me as Fellow a week or two before. He opened the conversation and I was able to remind him who I was. He asked how I liked Cambridge, and I said that it was excellent with the added bonus of being in the same town as ones work. I should have stopped there; but I added that, at Imperial College where I was previously, the sense of community suffered as at 5 o'clock all the academic staff scattered over 4000sq miles of commuter land. His face darkened, and he said, that it was not his fault and that if I bothered to read history I would see that the criticism was unfair. At the time, I failed to unpack what the Master had just said, although I noted the tone. I thought I was only making small talk, and was stunned into silence. Afterwards I gradually pieced together that the RAB Butler had come to us from a glittering Westminster career, and had held every senior cabinet post except Prime Minister. One such had been Minister of Education. He had apparently been involved in the decision soon after the war that Imperial College should **not** move out of London, or at least he felt responsible for it. I suppose once a politician, always a politician.

A new Fellow

My first terms in Trinity moved at quite a pace as I taught crystallography and materials science. It was not long before I was approached to advise on the College clock as its face was being refurbished and there was concern about corrosion. There were several different types of metal involved in the rebuild. I advised that they could use as many different metals as they liked but they had to ensure that each type was electrically insulated from the other. Whether this was actually done I do not know, but for the next couple of years or so while I was still in my probationary period as college lecturer I looked anxiously at the clock hoping any corrosion would not become apparent, or at least soon enough to count against my prolongation. After a few years I was doing my first stint on Council, and agreed to become a tutor. Those 10 years as tutor of side J were a

pleasure, as it was possible to do both that job, and the day job back at the lab by virtue of the excellent PA type support which Trinity provides for tutors.
Another Trinity responsibility that came my way was to run the punt scheme. It was not without interest. At one point we were worried at the poor life of our wooden punt poles, and I looked into whether an alternative material might work better. At that point a final year undergraduate in the Department had said he wanted to do a very practical project. So, I set him to design and build a prototype punt pole out of materials which would perform just as well as wood but last longer. He did this and produced a punt pole made of aluminium alloy tube with the ends glued in with a water resistant epoxy to keep the tube watertight. It was the first on the river, and appeared to work well, so he made the first 10 for Trinity punts. A final twist to this tale is when I submitted my annual punt scheme report to Council and was duly summoned to present it. I found myself being cross examined as to the risk of the new metal poles attracting lightning, I think I cobbled together an answer that metal and wet wooden poles would probably provide equivalent attraction to the bolt, but on a strike a wooden pole would definitely explode while there was a chance that the aluminium pole with the bottom end in the water would act simply as a lightening rod, leading to no more than a surprised punter. This sufficiently complicated the discussion and brought in other council members, and as the debate was threatening to have a life of its own, fun even, the Master closed it down and I heard nothing more. As far as I know, there are still, thankfully, no actual data points available regarding lightning strikes on punt poles.

Another river activity at the time was rowing in the Fellow's boat known as Octo Sociorum, and described by the vice master of the time in a speech from high table, as "Syntactically doubtful, and practically disastrous". Which seemed a bit unfair, albeit a good sound bite. However most of the our crew (Fig 2) went on to hit different heights which include: a Master of Trinity, a Vice Master of Trinity, a Provost of Kings, a Nobel Laureate, a Fields Medal winner and a Canon of Westminster Abbey, additionally there were two more FRS's and an FBA.

Research

I promised some account of my research, but I will confine myself to an overview as there are several hundred papers out there and a book or two. My research in Cambridge was influenced by my on-going interest in the internal structure of polymers. I got to know many of the commercially important polymer molecules very well, counting each one studied amongst my friends. At one point we were investigating the diffusion of organic liquids into Perspex and became fascinated by the kinetics of the process which were linear with time, whereas all theory available predicted a square root dependence. This led to a development of an understanding of what was going on, and was modelled using an early variation of Finite Element Computing using the University Main Frame computer, a state-of-the-art machine in that it used transistors rather than valves. My first computing experience as a research student had been on the valve based EDSAC machine, with a delay line store. Just a year or two ago, it was pointed out to me that a fairly recent reference to this diffusion work described it as the "classical theory of Thomas and Windle" which reminded me that I must be getting old, and in that sense it was good preparation for this evening.

However my primary interest was in ways in which polymer molecules organised themselves and how one could measure and describe the internal structure of plastics where the level of order was intermediate between a truly amorphous solid and a crystal. So, much to the bemusement of my American colleagues in the diffusion field, I let that work run down to concentrate on the challenging issues of internal structure.

I had started with one of the most flexible molecules, that of polyethylene, and gradually moved to more rigid molecules some of which also formed liquid crystalline phases. There was a whole period when liquid crystalline polymers were the theme of the research group and led to book of that name published in

its first edition with a former post doc of my group, Athene Donald, now Dame Athene and Master of Churchill.

It was a gradual understanding rather than an eureka moment which led to the appreciation that in polymeric materials there is a perpetual internal conflict. Long chain molecules (polymers) are entangled and form a network. It is these entanglements which not only enable rubbery behaviour, but also provide a polymer, for example polyethylene, with much greater strength and flexibility than its short chain, chemically similar, equivalent such as paraffin wax. However, molecules will always tend to organise themselves so that can pack most closely, which normally means lying parallel with each other, and that is where the battle begins, because the randomly distributed entanglements oppose the achievement of full parallel alignment throughout the sample. The resultant internal structure normally consists of regions where the chains lie parallel, but between these regions the chains move off in different directions towards their next fixed entanglement point, only to then encounter another region where parallel order holds sway. For flexible polymers, where the ordered regions are fully crystalline, some of the chains need to double back completely in order to accommodate the cross sectional area mismatch, which is the famous chain folded model, a concept I was steeped in from my earlier time in the Bristol physics department. Where molecules are too stiff to double back on themselves, the transition from ordered region to disordered is more gradual.

There were of course interesting offshoots to this work. Straight, rigid molecules tended to make crystals with melting points so high that the polymer could not be melt-processed without chemical degradation. So, molecules were introduced which were straight but with chemical sequences which did not repeat perfectly along their length (random co-polymers). The result was that except for thin regions, where non-periodic sequences had themselves found a match with neighbours, crystallinity was much reduced, and the polymer had a lower melting point. Finite element routines returned at this point, now much more

sophisticated than in earlier years, as we were able to model in three dimensions the development of liquid crystalline structures which showed singularities called disclinations. These occur in director fields, and are, giving a two-dimensional example, the centre point of the ‘whirls’ on any fingerprint.

Another interesting off-shoot was the structural investigation of a molecule which had arc-like rigid sections. This was the molecule, PMMA, which is marketed as the plastic ‘Perspex” I was a little irritated when colleagues began to call it my ‘banana’ molecule, but I had the interesting experience of lecturing to ICI and explaining to them the real reason why their product was such a good, clear glass.

Around the turn of the century, I was shown some electron micrographs of carbon nanotubes and realised that in their most simple form, they were the ultimate rigid polymer molecule. Much of the initial work was applying principles of polymer science developed over decades to this new material and we developed a process to synthesise the nanotubes in a gas-phase reactor at 1100°C. The structures showed many of the features of more conventional liquid crystalline polymers. The fibres we spun from the cloud of nanotubes proved to be exceptionally strong and stiff and excited considerable interest. However, the nano word had its own power and I found I was on a bandwagon, which enlivened the final 15 years of my research career, with the additional excitement of a spun out company, Q-Flo, which still trades in the UK, although now owned overseas.

To talk to you this evening is of course to give a personal account, however experimental research is a team activity, and I have to acknowledge the students, post docs and academic visitors who did most of the hard grind and I hope have been properly acknowledged in their co-authorship of the resultant publications. They are too numerous (100+ over the years) to mention individually, but the research is every bit as much their work as my own.

CMI

University responsibilities increased in the 1990s and I had the privilege of being Head of Materials Science and then of running the Cambridge-MIT Institute (CMI) from the Cambridge end. CMI was a significant link-up between the two Universities fuelled by £50M from Gordon Brown (then Chancellor of the Exchequer). The biggest challenge was that the money and the idea of linking with MIT belonged to the Treasury, but they had then subcontracted it to the (then) Department for Trade and Industry (DTI) for implementation. So as the DTI put it: if it is a success it will be the Treasury's success but if a failure, it will be our failure. So they told me to "take no risks, do not try to do anything new" neatly undermining the whole point of the exercise. Anyway, CMI worked, it should have with that financial horsepower behind it, and the student exchanges with MIT were probably the most beneficial and long lasting benefits. You never go wrong spending money to give bright students new experiences.

More recently

Since my official retirement, I have covered in Trinity for the Dean of College on three occasions, indeed I have just finished a year long stint doing just that. The job does take one into some of the darker corners of College life, but my lasting memories will be of the huge and ever expanding gulf between the generations. Electronic communications, especially social media, are a step, in just a generation, comparable perhaps to the invention of writing, or at least of the printing press. Our student's friendship circles seem often to be defined in their phones, rather than by geography of living on the same staircase, or playing in the same sports team. They also see this as their world and when I had to step in as Dean, possible through the misuse of Snapchat or something of that ilk, I have been made to feel like an intruder, despite, that is, taking classes from my granddaughter so as to be up with the jargon and protocols. However, on a difficult Dean day I would mumble to myself the mantra that at least 95% of our

students are always pure delight. It helped, for it is true. I have also enjoyed the post retirement job of teaching materials to our engineers.

Being involved in the College's response to climate change is another privilege. However, the deeper I delve into the data, and the arguments arising from them, the more deeply I am worried. Global warming is very real, and there is not the slightest evidence yet of any successful mitigation of this juggernaut which is capable ultimately of decimating humanity. This is one of the great remaining challenges to mankind, and to me too. It is very much work in progress.

Flying

Perhaps life does tend to a circle. Two decades after my RAF experience as an undergraduate, I took up flying again, as a civilian this time, and had many wonderful touring trips in our trusty little Cessna, flying well north of the Arctic Circle in the midnight sun, also trips to Malta, to Gibraltar and to Estonia. With Janet we used to holiday in France particularly flying from one grass strip to another, waiting for somebody to appear and then asking for a recommendation of somewhere interesting to eat and spend the night. We found that the French were particularly good at answering that question, and would often drive us to the destination. The experiences we had are still recalled from time to time and give renewed pleasure.

The flying also led to my involvement in the Mission Aviation Fellowship (MAF), a third world airline operating small aircraft into and out of extremely challenging grass and mud strips. My first job was to deal with the unacceptably high accident rate. We had to achieve a culture change, so that the determination of our young idealistic pilots to save lives in emergency situations, became properly tempered by the overall requirement to do it safely. Eventually I ended up chairing MAF's European Board which presented a range of inter-cultural challenges, and made me wonder how the EU was ever going to work.

Steam

Another such circle of life was steam engines. An early enthusiasm at school was train spotting with days spent on the platform ends of London termini looking at the wonderful steam engines of the era, machines which you could see working in several different respects, with an evocative smell too boot.

So when I, mistakenly, thought that retirement at aged 67 in Cambridge, actually meant retirement, I built myself, using kits, a third scale model of a road steam engine popular in the early decades of the last century, generally know as a traction engine. The model weighs about a ton and trundles around our garden giving rides. It seems to give great pleasure not only to the local children but their parents and grandparents alike. (Fig 3) It has also visited College bearing proudly its own third scale parking badge.

Final

Overall my Cambridge life has orbited around a very happy home and family life, and the unfathomable privilege of being a part of Trinity. As a retired Fellow, still able to carry out some of the duties which might otherwise overburden our teaching Fellows, the pleasure of being involved continues. However, I hope I will never forget the tension in mid career between doing research on a world stage and teaching in College and in the University. I dare to think it was a creative tension.

I hope the Port and Claret has helped to ease the burden of listening to somebody having to talk about himself.

But at least it is only the once……

Thank you so much for coming this evening, and drinking my health. It is an occasion I will never forget.

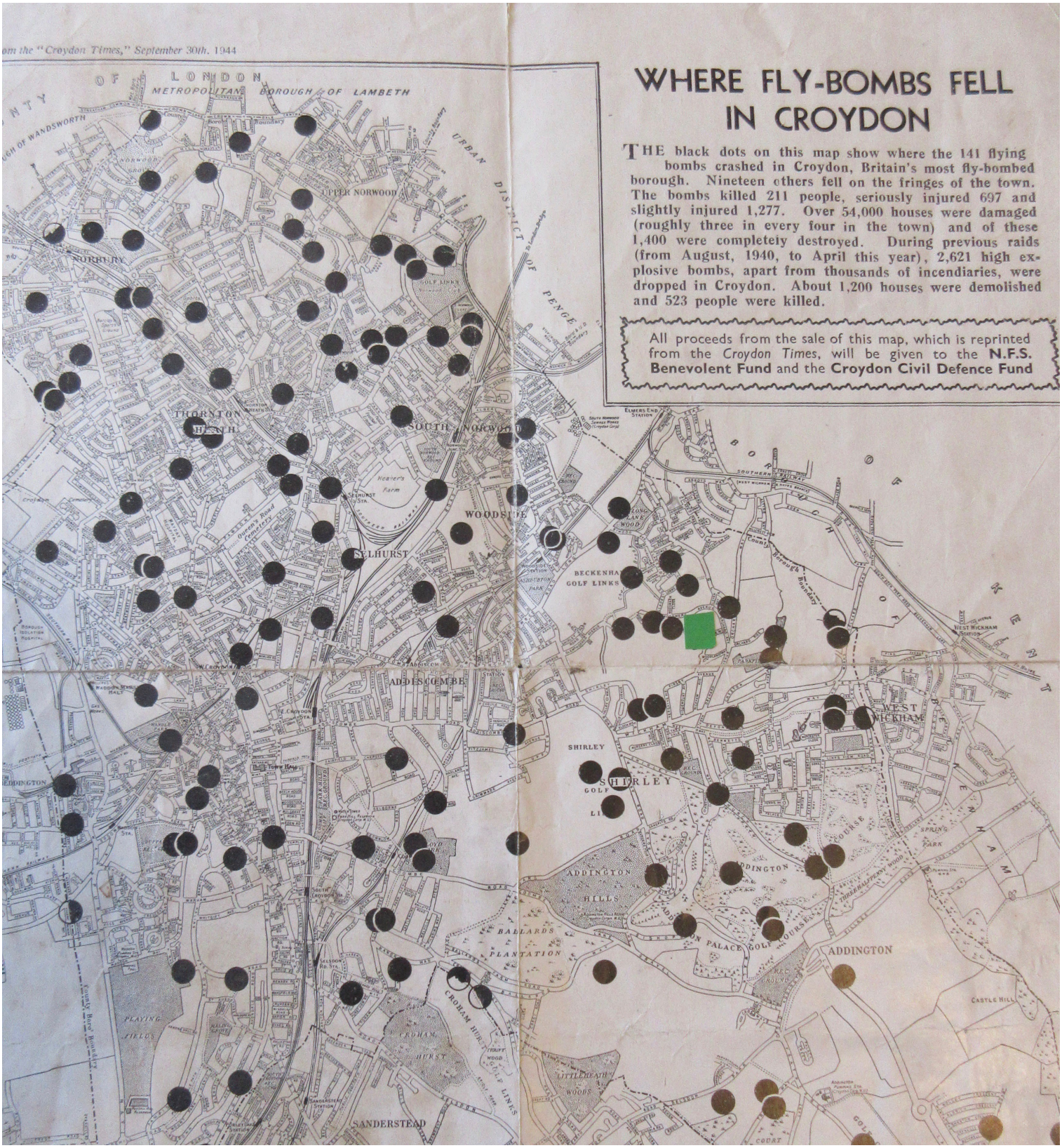

Fig 1 Map of flying bomb explosions in Croydon by September 1944. Home marked with square.

(a)

(b)

Fig 2 Octo Sociorum circa 1980 (a) racing in the bumps (b) bow six.
Crew: Simon Keynes (bow), Robert Reiss, Alan Windle, David McKie, Bela Bollabas, Greg Winter, Malcolm Swinbanks, Mike Proctor (stroke), Alan Baker (cox)

Fig 3. ‘Retirement’ project. Third scale model traction engine, in steam.