On How a Kenya Policeman Ended Up – Working in the Research and Development Division of a Supercomputer Manufacturer in America

Jitze Couperus

When the Belgian Congo was granted independence in 1960, the country deteriorated into chaos within the first few days. Secessionist factions and inter-tribal warfare resulted in wide-spread anarchy, looting and bloodshed.

It was this event that also triggered my leaving school early and even before I had sat for my final exams (for a “Higher School Certificate” or what were also known as “A Levels”). The Prince of Wales School was a boarding school for about 600 boys, and the dormitories were needed to house the stream of refugees from the Congo. I was a “senior” who had spent some years in the Combined Cadet Force while at school – referred to as the CCF in that context but probably more familiar to American readers as the equivalent of ROTC. While other boys were sent home, I was asked to stay on at school to help liaise with the Belgian refugees (I spoke Dutch) and help organize some of the inevitable chaos arranging for food, clothing and sanitation as the stream of refugees threatened to swamp our resources.

However, once the situation at the school was under control, it was decided that my talents could be better used closer to the real action. Accordingly I was “called up” into the Kenya Regiment and then rapidly seconded (i.e. transferred) to the 4th Battalion Kings African Rifles in Uganda to help them deal with the ever growing refugee problem. This led to a whole new set of adventures that fall outside the subject of this tale – suffice it to say that I served with the KAR for around six months and then was “demobilized” to become a civilian policeman rather than a soldier.

Meanwhile the situation in the Congo was increasingly being seen as an omen of things to come in Kenya, as it too approached the date set for its independence from Britain. More and more of the expatriate ”colonial civil servants” were not renewing their employment contracts and were returning to Britain or moving to other countries where they saw the future as more predictable. Meanwhile, I was still in the early part of my two years in Her Majesty’s employ as a military conscript. Having been demobilized from The King’s African Rifles, and now designated as a Police Officer with The Kenya Police, I had been relegated to temporarily filling various vacancies in the Civil Service until more permanent and indigenous staff could be recruited and trained.

It was in this environment that the Colonial Government decided to offer certain people an incentive to stay on until independence came to The Colony, and not make the situation worse by joining those seeking greener pastures. It was in this context that I was made an offer – Her Majesty’s Government would pay for my retraining in a new profession if I stayed on for the duration. They would not hire me into a new job after independence – but they would pay for my re-education.

Around about this time, fearing American dominance in the field, Parliament in Britain was taking steps to consolidate a budding, but very fragmented, British computer industry

into just one or two companies that would then have the critical mass to survive and perhaps succeed. Along the way, it also determined that the severe lack of people skilled in this field threatened the health of the industry in the U.K. As a result the Government decided to foster the development of a “profession”, based on a defined body of knowledge, by setting up a formal education and certification mechanism along the lines of an “apprenticeship” scheme – much as had existed for many years in other fields such a Blacksmiths, Barbers & Surgeons, Master Mariners and so forth. To that end, the British Post Office was charged with taking initial steps in this direction.

Bear in mind, that in Britain, the “Post Office” did more than deliver the mail. In those days it was also “The Telephone Company” – responsible for all research and design as well a deployment of the telephone, telex, and telegram services in the U.K. Less well-known was its history in the very early development of computers in WWII.

Meanwhile, and purely by chance, I had already done some part-time moonlighting work for the East African branch of a company called “The British Tabulating Machine Company Ltd” involving punched card accounting machinery. This company agreed to hire me if I accepted the offer from the Government to be apprenticed for two years to The British Post Office in the U.K. to become schooled in a technology slated to replace the old (electro-magnetically driven and hard-wired programmed) accounting machinery – something called “Computing Machinery”.

And thus it was that I became employed by The British Tabulating Machine Company Ltd (which later changed its name to International Computers & Tabulators, or ICT and then later again to ICL). They paid me a small stipend, while I was also signed up as an apprentice with Her Majesty’s GPO (i.e. the Post Office) for my “education”. And here, the sheer luck that I had already achieved my “City &Guilds” Amateur Radio License (i.e. Ham Radio License in American parlance) played a role in the particular path my apprenticeship would take.

I spent 2 years in the U.K. on what was called a “Sandwich Training Scheme”. About half of my time was to be spent at the Post Office Laboratories in Dollis Hill (London NW10) and the “Post Office Training School” at Bletchley just north of London near what eventually became the town of Milton Keynes. This occurred in sessions, each of a few weeks duration, alternating with other half of my time which was to be spent on brief assignments for my employer (known by then as ICT) working with customers around the U.K. The periods in this “Sandwich Course” that I was working with the Post Office, I was classified as an “apprentice” working under a tutor referred to as a “master”. In my case, this was a gent by the name of Tommy Flowers about whose background I knew absolutely nothing.

This is not surprising, because his prior accomplishments were at that time still shrouded in secrecy. Many years later I found out that he was part of the trio of Alan Turing, Bill Tutte, and Tommy Flowers who formed the intellectual pipeline that lead from Turing’s abstractions to real hardware in the form of a very early computer christened with the name “Colossus”.

By the time I met him, Tommy was actually also doing work for Standard Telephones and Cables (at Harlow in Essex and usually referred to as STC – a manufacturing company

that was closely involved with the Post Office) who were persuaded to design the actual hardware and implement a Dutch design known as the ZEBRA (Zeer Eenvoudig Binair Reken Automaat) developed by Professor van der Poel, but for which he could find no backing in his native Holland. But this connection was just a coincidental aside to the work assigned to me by Tommy Flowers.

For my “final practicum” as an apprentice, Tommy assigned me a task – there was a computer program running on a “special” machine in Cambridge in a “Language Lab” somewhere (I believe it was a hacked-up variant of an ICT 1202 but can’t be sure) and the authorities wanted that program to be speeded up by a factor of ten. My assignment was to attempt to achieve this goal by designing a new hardware instruction, then building the actual hardware, and retrofitting it into said computer and then recoding a critical software subroutine in this program to make use of the new instruction.

Here follows a brief aside for my more technically inclined readers – feel free to skip the next two paragraphs if you are not a computer geek.

I achieved a speed-up factor of about 30 fold... They never told me what the program actually did but I concluded later (by “joining the dots”) that it was very likely cryptanalytic in nature and (as near as I could figure) based on a software implementation (emulation) of Zygalski Sheets as developed by pre-war Polish code breakers – but now carried umpteen steps further in sophistication.

I’m not sure whether the idea was Tommy Flowers’ or mine, but we ended redesigning the data structures used by the program. We did this by notionally tipping the stack of sheets on its side in memory, and devising a new instruction that would count the number of “1” bits at a particular X,Y co-ordinate through the Z dimension. i.e. all the matrix entries for a given X,Y coordinate in the stack of sheets were stored as either “0” or “1” in a single computer word. The number of bits that were “on” at a particular X,Y coordinate in a stack of sheets could thus be counted using a single instruction rather than a loop of multiple instructions that had to be executed many times. In CDC parlance, this became known as the “pop count” instruction and graced every machine ever designed by Seymour Cray.

I’m not sure whether Cray invented this afresh and de novo or whether the British offered a helping hand... All I know is that some years later I was working in Holland for ICL and wanted to emigrate to the U.S.A. – so made some enquiries (IBM, Univac, Burroughs, Honeywell, et al) but rapidly found out that in the absence of a university “bachelors” degree, let alone a “masters”, I wouldn’t even get through the door for an interview. So I applied at the Australian Consulate in Rotterdam for the paperwork necessary for a visa to emigrate to Australia – in those days the Aussies would pay the passage for a Dutchman to come work in Australia on condition that they would go home after two years and then become eligible for permanent residence in Australia if they then made their own way back there..

Merely requesting the necessary papers for this visa had a startling effect... within days I received an invitation to join an American for a cup of coffee in The Hague for a chat. We arranged to meet in a Restaurant/Café called “De Posthoorn” opposite the American Embassy.

And here another brief aside: While working at Bletchley, nothing like a formal “security clearance” was ever mentioned. But I do remember a brief lecture where the subject of “inquisitive foreigners” came up. In essence, our class of half-a-dozen apprentices were told to be cautious of any “Hungarian Refugee” because that might be a cover for a Russian - likewise a West German might actually be an East German. And any American with crew-cut hair, and wearing white socks with large wing-tip styled shoes most surely did not work for the Ministry of Agriculture. So just be careful…

I met the man who had invited me for coffee at De Posthoorn. And… as if cast for the movie role, he had crew-cut hair and was wearing white socks with huge wing-tip shoes. He introduced himself as an Embassy attaché.... His first question was whether I was the same person that had worked with Tommy Flowers. His second question had to do with what my motivation was to go to Australia? I wanted to ask him how he even gained the knowledge to be able to pose either question, but I replied that I wanted to leave Holland and work for a computer manufacturer, but nobody in the USA would even look at me, so I was going to try and get a job with ICL in Australia...

My embassy contact assured me that getting a job with a computer company in the U.S.A. would not be a problem – and would I like him to make the necessary introductions for me?

To cut a long story short, I received a telephone call a few days later from somebody named Seymour Cray (whom I had never heard of) and who offered me a job with a company called Control Data Corporation (more usually referred to as CDC) and who could “handle” any visa requirements... I had a choice of working in hardware research and design in a place called Chippewa Falls (Wisconsin) or in software research and design in a place called Palo Alto (California)

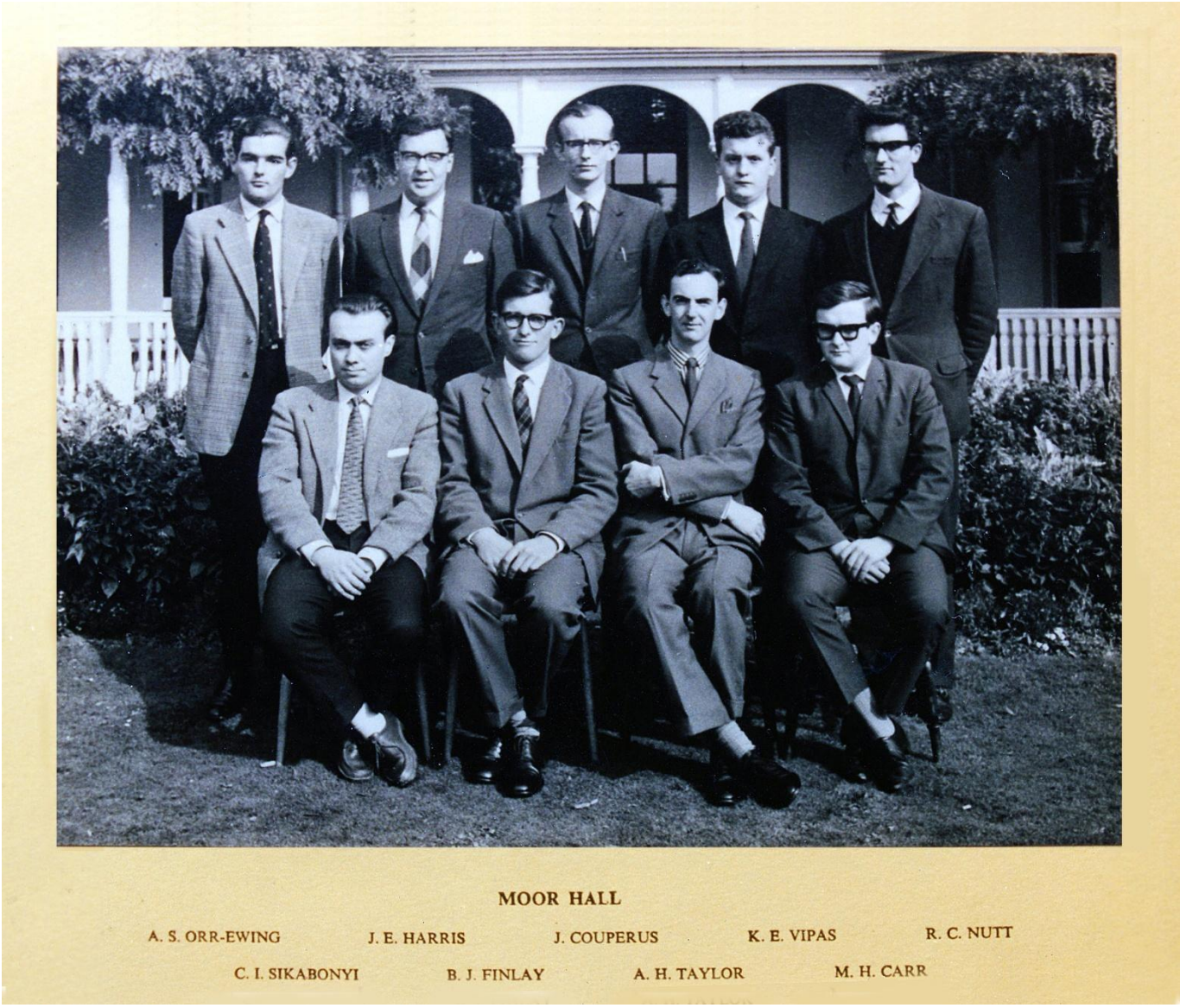
Some 20 years later I found out more about who Tommy Flowers was, and another 10 years after that I figured out that “the Americans” must have thought that I knew what “my” instruction was used for and didn’t want me wandering off somewhere with this knowledge – better to have me gainfully employed in the USA and safely out of harm’s way. I have to assume that “The Americans” thought I knew a lot more about what was involved in that program for which I implemented the new machine-code instruction and rewrote a particular software sub-routine to make use of it. Truth is I didn’t have much more than a very vague idea of how the program worked – let alone what it was trying to accomplish. I had a detailed worm’s eye-view of a very small piece of a much larger program.

By the time I joined CDC in Palo Alto some months later, I was amazed to find that the supercomputer that Seymour Cray had designed a few years earlier (The CDC 6600) had an instruction in its repertoire that matched almost exactly the action of the one I had designed under Tommy Flowers’ tutelage. And since then, every computer designed by Seymour Cray had such an instruction in its repertoire…

About 5 years after moving to California and working for CDC, I happened to pass through the bookstore at San Francisco Airport prior to catching a cross-country flight. I was looking for a cheap throw-away paperback to alleviate the boredom of the flight

when a hard-cover book caught my eye. On the cover of this book was a picture featuring a tree in a garden with a mansion in the background. The image rang a bell somewhere in my memory. The book was called “The Ultra Secret” by F.W. Winterbotham and the building shown in the background was the mansion at Bletchley Park. I bought the book and read it with some amazement – by “joining the dots” that the book filled in, it became much clearer to me what was involved behind the background of my time as “a Post Office Apprentice” in Bletchley. This was one of the first books to give some insights into the history, but still very limited. Subsequent books filled in more, until eventually the name of Tommy Flowers was mentioned and his role described. My suspicions and surmises were fleshed out with more detail - and the full import struck me of the “master” under whom I had been educated.

And thus it was that a Kenya Policeman with a High School education under his belt, ended up retiring some 40 years later, the last 32 of which, working for Control Data Corporation in that part of the world that is now known as Silicon Valley.



MOOR HALL

A. S. ORR-EWING J. E. HARRIS J. COUPERUS K. E. VIPAS R. C. NUTT

C. I. SIKABONYI B. J. FINLAY A. H. TAYLOR M. H. CARR

This is a picture of the members of a “class” at ICT’s training establishment at Moor Hall in Cookham – a small village not too far from London. Just a few of my colleagues in this class were also “apprentices” undergoing training at the Post Office.

Postscript – and an explanation for what follows.

After the first Oral History “interview” had been made to happen electronically across The Atlantic via Skype, a rough draft of the resulting text was emailed to me for me to edit or clarify as appropriate.

I fiddled with some wording and added a comment on the side - I felt that while the document covered my experiences adequately, it did not do enough to give the reader an understanding of the role played by Tommy Flowers. In hindsight, his teachings were a major contribution in helping to establish the body of knowledge that later grew into, and became known as, “Computer Science”.

This comment must have hit a nerve somewhere – it triggered the dispatch in person, of a Doctoral Student in this very subject, from the U.K. all the way to California to talk to me.

As a result of this face-to-face meeting, I created the following addendum after the original “oral history” had been transcribed and edited. It was primarily triggered by the realization (by numerous people – not just myself) that Tommy Flowers with his broad knowledge and experience, did much more than just help build “the bedstead” and subsequently the series of Colossus computers – which in turn had such a huge impact in both the history of WWII, and more broadly, the subsequent Information Age.

I wanted to identify Tommy Flowers as probably being the only man in Britain at that time who possessed the skills and practical experience that straddled the two distinctly different technologies that made it possible for his achievement.

It enabled him to turn abstract ideas expressed in Boolean Mathematics into logic diagrams – and translate these in turn into the physical valves (tubes), resistors, capacitors and inductors that resulted in an operating example of a Turing machine - the actual hardware for Colossus.

Then looking back on the physical manifestation of the machine in order to be able to teach about it, he then re-abstracted it into the common atomic components that went into the construction of the completed “molecule” known as a computer – entities like adders, shifters, “and, or, and not” gates, sequencers, and so forth.

From this evolved the foundation for has evolved into today’s “Computer Science”.

An Explanation - Where Tommy Flowers Fit In, and What Made it Unique.

At the time I was an apprentice under Tommy Flowers, I could not appreciate the significance he had in the history of computers. Over the years, people have realized and appreciated the contribution he made, but few have I think appreciated the extraordinary circumstances that made him probably one of the few people in the world at that time who had the knowledge and experience to enable him to do what he did.

Bear with me while I explain…

Obviously I can't remember exactly the conversations we had while he was my "master", but the following is a distillation of what I gathered from him during the course of my apprenticeship.

When the telephone first became popular in the early 20th century, the technology was far from as automated as we know it today.

At that time, to make a call, you lifted the phone "off the hook" and either tapped the hook or cranked a small generator to make contact with a human "switchboard operator". This was a person seated at a panel where manual connections could be made from one telephone line to another. You asked the operator to connect you to the line of the party you wanted to talk to, and that's how the connection was made.

In the years leading up to WWII, this process slowly became automated through the use of what today we call the "Dial Telephone". This innovation depended on the user "dialing" successive digits of the telephone number, whereupon the instrument would emit a series of pulses to the "central exchange" which effected the connection to the other party's line based on the pulses it received.

The technology to do this was all "electro-magnetic" – as opposed to electronic. In principle the "exchange" was constructed using two main kinds of devices – the "relay" and the "stepping switch" (also known as a "uniselector"). Based on the train of pulses received from a telephone that was being dialed, relays would be pulled over and stepping switches would travel over a series of contacts to finally select and land on the desired contacts to create a continuous circuit between the person dialing and their intended contact.

These exchanges rapidly grew in size and, being mechanical in nature, were prone to wear and tear and losing adjustment. As the number of components in an exchange (relays and uniselectors) grew, so the chances of failure in the system somewhere at any given moment grew worse at an accelerating rate.

And this is where Tommy Flowers came in.

Tommy had trained as an electronics engineer. As such, he was familiar with the limited set of basic components that were available to work with, such as resistors, capacitors, inductors, coils and valves (called “tubes” in America). Electronic engineers knew how to use these components to build two basic kinds of circuits – filters (or oscillators) and amplifiers. A typical radio for example might contain a series of filters to extract (tune) a particular frequency of radio signal and some amplifiers to boost the signal to a level where it could eventually power a set of headphones or even a loudspeaker.

Tommy Flowers was such a man – and he got it into his mind that it should be possible to build a telephone exchange with these fundamental components and – because such a device would have no moving parts – such an electronic exchange would be far more reliable than any exchange built with electromagnetic components.

The problem he faced however, was that the general level of “electronic” knowledge at that time revolved around the building blocks described above (filters and amplifiers) and signals composed of sine waves, not the “pulses” involved in a typical telephone exchange. There were lots of skilled engineers who knew how to design devices that filtered and amplified sine waves – but no one had tried to build circuits to do the things that electromagnetic relays and uniselectors did – making decisions on how to switch and route circuits based on counting strings of (square-waved) pulses.

So in the years leading up to WWII, Tommy had built some experimental electronic rigs trying to figure out how best to achieve the functionality required by a telephone exchange. He was moderately successful, but only on a small scale. The reliability he was looking for turned out to be elusive. The absence of moving parts had a positive effect, but depending on valves with heated filaments proved to be the weak point. Valves tended to “burn out” more than expected, and it was easy to extrapolate that a device with thousands of valves (where failure of any one could bring the whole thing to its knees) would not achieve the reliability being sought for.

In the course of this, Tommy had built a wealth of experience in how to design and construct some of the basic building blocks that would be required. This knowledge was built up not on the basis of some theoretic model, but more on the practical task of copying the known functionality of an electromagnetic-based telephone exchange. It was only later that the pattern became clearer. Just as radio technology was based largely on the building blocks of filters and amplifiers, Tommy eventually was able discern a pattern of the basic electronic building blocks he would need for a telephone exchange. It boiled down to a handful of different building blocks – including the “flip-flop”, (multiples of which could form a “counter”), the shifter, and the Boolean operators of “inversion” (also called “not”), “and”, “or” and “exclusive or”. And then to glue it all together, a “master clock sequencer” which could cause a pre-planned series of operations to occur.

This categorization of architectural building blocks only gelled and became clearer over time – it was still just more of a gut feel when Tommy became somehow involved with the team at Bletchley Park. I don’t think he ever told me the circumstances of how this happened, and he certainly never mentioned Colossus. But it was this basic set of

knowledge that he felt was necessary for the well-trained apprentice to know and be thoroughly familiar with in order to qualify. This was what he endeavored to teach me.

At this point and from his perspective – it was the underlying hardware that formed the primary focus of “computing devices”. I don’t think it was apparent yet in his mind (or of his “engineer” colleagues) that the software was equally important in the overall scheme of things. “Programming” (or “software” as we would call it today) was more of an afterthought, a relatively minor detail that could be tweaked and adjusted later after the physical device as a whole had been manifested.

And it was in this context that Tommy set me the task (and worked with me) to take an existing hardware and software combination (a computer and a program as we would call it today) and figure out a way to speed it up – hopefully by at least a factor of ten if possible. As explained earlier, we accomplished this and more. We designed a new hardware instruction to add to the repertoire of an existing computer, and modified a critical section of the code in “the” program to make use of this new instruction. Tommy later informed me that we achieved a speed-up factor of around thirty.

Unfortunately, I never got to see the actual computer involved, or know definitively who it belonged to. We breadboarded the initial design of the new instruction in the “shop” at Bletchley and it was refined by a wider group of about four of us in Dollis Hill. The final production device was assembled at the ICT factory at Letchworth Garden City. I assumed the computer involved was some derivative of the ICT 1202 because the logical design as well physical implementation appeared to be crafted to fit into structure of that machine as well as use the same family of physical bits and pieces used in that series of computers. I was under the impression (based on a vague memory) that the machine itself was located at the “Cambridge Language Computer Laboratory” but I never got to visit it. I was informed a few years ago that such an organization did indeed exist, but they did not have an ICT 1202 type of computer, so that remains a bit of a mystery.

It was only many years later that I found out more about Tommy Flowers and his earlier accomplishments in the design and construction of Colossus. And only then did the significance of his earlier lonely struggles to transition from electro-magnetics to electronics strike home. That a man with this particular background and practical experience existed in Britain at that critical moment in time – and then, on top of that, that he was then somehow identified and brought in to work on the “bedstead” that led to the construction of Colossus – a series of circumstances that seems little short of miraculous today.