<u>Recollections of early AI in Britain: 1942-1965</u> (video for the BCS Computer Conservation Society's October 2002 Conference on the history of AI in Britain).

My name is Donald Michie. Let me first introduce my friend Michael Bain, who has very kindly agreed to conduct this interview. Michael graduated in Psychology from Edinburgh and after gaining a Diploma in the Artificial Intelligence Department he joined the Turing Institute in 1987. During the fifteen years since then he and I have worked together on a number of scientific projects, to our considerable mutual enjoyment.

What was your earliest contact with the idea of intelligent machinery?

Arriving at **Bletchley Park** in 1942 I formed a friendship with Alan Turing, and in April 1943 with Jack Good. The three of us formed a sort of discussion club focused around Turing's astonishing "child machine" concept. His proposal was to use our knowledge of how the brain acquires its intelligence as a model for designing a **teachable intelligent machine**.

What was his basic idea?

Turing's belief about intelligence was that the **PROPENSITY** is **INNATE**, but the **ACTUALITY** has to be **BUILT**. For him the crux was the brain's ability to make sense of its inputs, that is to **understand** them. And how would we tell whether we had succeeded? To assess degrees of machine understanding he was later to propose what is celebrated today as the **Turing Test**.

So how did he see AI's task?

AI's first task was to build a **propensity**, which means a **general learning program.** The second task would be to **train** and **educate** this "child machine".

How did Turing's conception affect you?

It gripped me. I resolved to make machine intelligence my life as soon as such an enterprise became feasible. During the 15-year wait for hardware facilities, I became a geneticist. In summer 1948 I was spending my days at **R.A. Fisher**'s lab in Cambridge, and my evenings on the **MACHIAVELLI** challenger for Turing and Champernowne's blue-print for playing chess. Turing called it a "paper machine". With my wartime colleague Shaun Wylie -- he was now back in Cambridge as a don at Trinity -- we developed our own rival paper machine. Turing was intrigued, and decided to play the two off by programming the "Manchester Baby" - precursor of the Ferranti Mark 1. He was thwarted (rightly) by its designer and the guardian of its scarce resources, **Tom Kilburn**.

What happened next?

In 1950 I visited the National Physical Laboratory (NPL) where the pilot Ace was engaging all comers with its faultless play of the game of tic-tac-toe. The experience encouraged me to hope that technical feasibility of experimental work might be in the offing. In 1959 the NPL symposium on ***The Mechanization of Thought Processes*** came out. Around the same time an Edinburgh colleague, asserting that learning machines were an impossibility, challenged me to prove him wrong. In response I built a contraption of matchboxes and glass beads, the **M**atchbox **E**ducable **N**oughts-**A**nd-**C**rosses **E**ngine. It won me my bet and an invitation from the US Office of Naval Research to visit Stanford.

What did you do at Stanford?

I programmed in FORTRAN a general trial-and-error learner based on **MENACE** for the IBM 7090, using an IBM 1620 for hands-on interactive program development. Bernard Widrow who developed the Adaline Perceptron-like machines had a student using them to study machine learning by imitation. The task was to balance a pole on a motor-driven cart, I wondered whether machine learning of such a task by unaided trial and error might be possible.

And did such re-inforcement learning prove to be possible?

Eventually. But full success did not come until after my return to the UK. Still short of funds and facilities, I ported my program to the Ferranti Pegasus with the help of one of their staff programmers, **John Martin**. The algorithm, BOXES, was published in the British *Computer Journal*, -- the first-ever working demonstration of re-inforcement learning by machine. But I was more than ever frustrated and upset by the lack of University provision of electronic computing. The then Minister of Science and Education thought that "computing" meant desk calculators. The war-time **Bletchley COLOSSUS** machines were still an official secret. This early UK development of high-speed electronic computing was quite unknown.

How long did the Colossus machines remain secret?

Until 1972, when the fruits of a brilliant piece of sleuthing by **Brian Randell** surfaced in his paper in the seventh volume of **Machine Intelligence**.

So what came after Stanford?

On my return I had secured a few hundred pounds from the **Royal Society** for initial experiments. Concerning the national computer-blindness I lobbied everyone in sight. Finally in Whitehall I waylaid **Christopher Jolliffe**, a senior official of the Department of Scientific and Industrial Research (**DSIR)**. An immediate by-product was an invitation to apply for funds for my own experiments.

And did you apply for the money?

The **Department of Surgical Science** in which I was employed as an immunogeneticist lacked floor-space for such work. With the connivance of the Dean of Medicine, **John Brotherstone,** later Chief Medical Officer of Health for Scotland, I moved into an abandoned University cottage in **Hope Park Square**, paying my handful of students and other helpers from the fast-shrinking Royal Society funds. The Head of my Department, Prof **Michael Woodruff**, was eventually calmed, and his Department was later compensated with a new Readership in place of the one I had hi-jacked. But the survival of the **Experimental Programming Unit,** as we styled our band of irregulars, hung in the balance.

So what happened to the infant Experimental Programming Unit?

The worst. **Christopher Strachey** had long been campaigning for "nonnumerical analysis" as the wave of the future for computing. But **numerical analysts** still dominated all matters involving calculation. The hoped-for DSIR grant was declined. The Hope Park Square irregulars now faced imminent extinction. I threw myself on the mercy of my Vice-Chancellor **Edward Appleton**, a distinguished physicist known for the "Appleton Layer" of the upper atmosphere. He cleared his morning appointments and diligently grilled me on **"machine learning"** and **"heuristic programming",** notions then unheard of. Finally he turned back to my troubles. "Tell me," he enquired gently, "Does anybody know of this DSIR problem?" On hearing that the news had not gone further than myself and my secretary he continued: "Ah well! I do not think you should consider it necessary to *burden* your colleagues with this knowledge. Meanwhile you seem to be going about things in the right way. There is nothing much that I can do. But I'll make a few enquiries." He also mentioned a fact which was quite new to me, namely that his previous job had been as Head of the DSIR,

Did he say from whom he planned to make enquiries?

No. But things suddenly started to happen, first with a visit from a Fellow of the Royal Society, **Ian Sneddon**, head of the Glasgow Mathematics Department. He looked keenly through what we were doing. **Jim Doran** was visiting from Oxford on funds from Norman Bailey's MRC Statistics Unit and he and I were looking at ways of mechanizing best-first searches of problem graphs. Our Graph Traverser algorithm I believe still plays a humble role at the heart of Austin **Tate**'s impressive suite now in world-wide use for automated planning. On the cognitive side two Psychology students, **Jean Hayes** (who later became my wife) and **Kay Pole** were collecting comparative data on human tactics over the very same set of problems. An early stalwart of our little group was **Andrew Ortony**. After an unsatisfying brush with the Science Faculty's undergraduate Chemistry course, he had concluded that there must be more to life! Ten years of fruitful work in Edinburgh were followed by a Cognitive Science career of international distinction.

All these were inspected by our visitor, Professor Sneddon. I explained to him Turing's notion of mechanizing human generic methods as preliminary to educating and training the machine.

And did Sneddon buy this interpretation of Turing's "child

machine"?

I don't know. But the miraculous news followed that DSIR had received new advice. The money was after all to be granted, and our expanding payroll was secure. This freed me for what followed, -- namely a 4-month release from the University to conduct a nation-wide survey and to report to DSIR on the state of University-based computing research in the United Kingdom.

What did your survey for the DSIR conclude?

The survey revealed stunning talent and intense eagerness among Britain's scientific under-40's to get into two areas of computing research in particular:

1. **Man-machine communication,**
2. **Machine intelligence.**

The report also uncovered an equally stunning wastage. These young brains were draining across the Atlantic in search of enablement. DSIR meanwhile had been re-formed, budding off the **Science Research Council** for handling the academic end of the research spectrum. It was this new body's **Computing Science Committee** under **Lord Halisbury**'s chairmanship that received my report. With a generous budget they settled down to implement its recommendations. For the two above-listed and (as Turing foresaw) intimately connected research areas, and for the Experimental Programming Unit, it was a godsend.

How was that?

From my country-wide travels my remit to identify frustrated research talent was now reinforced with the means to recruit. **Rod Burstall** from Birmingham, **Robin Popplestone** from Machester and **John Collins** from London all joined the ranks. The story of Rod's enlistment seems worth recalling. Armed with the new funds, I put to Christopher Strachey, himself one of programming's most gifted practitioners, the following question: "Who is the best programmer in the country?" Without hesitation he replied "A Birmingham student called Rod Burstall". I went to the phone and after a while located the young man himself. "I have urgent job information for you" I said, "Where shall we meet?" A puzzled voice proposed a local Chinese restaurant and gave me directions." I sped up the motorway, and in two hours was there. The restaurant meeting that followed took a little longer: Rod Burstall's approach has has always been conspicuous for its care and deliberation. At the conclusion he threw in his lot.

What was the new team's first move?

With the newly delivered Elliott 4120 machine, the new-formed team lost no time in embarking on what was later to become Britain's second time-sharing system, operational only a few weeks after **Maurice Wilkes** at Cambridge. We had been pushed, however, into radical innovation by dire necessity.

So necessity became the mother of invention?

Indeed yes! Our own efforts soon out-ran conventional bounds set by a RAM of some 72 Kilobytes and a backing store of punched paper tape files -- Elliott Automation's disc development had crashed! In a response to the emergency, Burstall, Popplestone and Collins designed the innovative **POP-2** language. They sought to unify the best of ALGOL and LISP with stack-oriented and super-economical interactive execution of functions. A starkly unitary design made the POP-2 language the basis at all levels, -- operating system, programmer's interface and user interface. A teleprinter in every room connected to the machine room, of which a bird's-eye-view was conveyed by a TV camera feeding a small monitor on every desk. I recall that when one typed a POP-2 command to the operating system, one could see on the monitor the "system response", in the form of the operator **Margaret Crosby** instantly mounting or dismounting this or that paper-tape file or magnetic film. But the Multi-POP system worked. After upgrading to an Elliott 4130, with disk-handlers to take over from Margaret Crosby, it came to support over thirty remote users throughout the United Kingdom.

Back in 1965, what were the other significant developments?

The incoming University Vice-Chancellor, the biologist **Michael Swann**, had been sweeping with a new broom. As a former friend and colleague from my genetics days, he was enthusiastic for the new studies. 1965 saw offical University recognition of the Hope Park Square irregulars, and the Unit's establishment as a full-fledged Department of the University offering a post-graduate Diploma in Machine Intelligence. Our newly recognised Department was able to colonize sufficient of the cottages around the Square to be able to throw a line to a new unit which **Bernard Meltzer** was set on founding. As the Reader in Electrical Engineering, he had found no echo in his own Department. But his new **Metamathematics Unit** in Hope Park Square carried seeds of outstanding intellectual creation. One has only to mention the mechanized theorem-proving work of **Boyer and Moore**, the conception and demonstration of the principles of **Logic Programming** by **Robert Kowalski**, and the later work of **Alan Bundy** and his school -- all of which flowed over into new academic developments of AI. These flower today in Edinburgh's multi-disciplinary **Informatics School**, presided over by the same Alan Bundy. Although I have set 1965 as my chronicle's horizon two other conspicuous processes had been initiated, with marked future consequences.

What were these processes of the mid-1960's?

First was our bond with **Ted Elcock** and **Michael Foster**'s group in Aberdeen. They early prefigured, and implemented in software, some of the core ideas latent in Kowalski's later logic programming. Much can be traced and deduced from the first few volumes of the *Machine Intelligence* series of which the first was launched in that same year. The key Aberdeen insight was to move the craft of programming from the idea of imperative commands towards a *declarative* style. The programmer should specify to the machine a set of **goals** and **sub-goals,** leaving it to the system to fill in the details of how best to achieve them. The second consequential event was a chance encounter with the noted engineer-psychologist **Richard Gregory** then at Cambridge. From this the basic concepts emerged for the subsequent Edinburgh robot project. In some respects of teachability and world-modelling, by 1973 it had surpassed even the most versatile offerings of the robotic world of today. We called that robot **FREDERICK**.

Another acronym?

Yes. It stood for "**Friendly Robot for Education, Discussion and Entertainment, the Retrieval of Information and the Collation of Knowledge**"!

Alan Turing would have understood exactly what we meant!

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