A WORLD FIRST WHICH AFFECTS EVERYBODY

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An historic event is one that affects you, and affects everybody. How many computers do you have in your house? Not the one you use, the ones that control things - in the refrigerator, in your car, in the washing machine, etc.

Recently the professional institutions have been researching where and how *Process Control by Computer* was achieved for the first time. The answer is that it was achieved in Britain, and the new aero museum in Bristol will feature it because it has been rebuilt by a team of enthusiasts. It controls an anti aircraft fire unit and the Bloodhound 2 guided weapon, both on the ground and in flight, and was one reason for the very long service life it had. The computer involved is the Ferranti Argus.

HOW IT CAME ABOUT

Digital computers for process control were developed at the end of the 1950s. They had different design objectives from computers for scientific or commercial use. The Ferranti Argus was among the first computers world- wide used for direct digital control. The Argus was invented at Ferranti's Wythenshawe Automation Division, Manchester, by Maurice Gribble. If credit for 'invention' must be assigned, it should go to the person or team that first had a clear vision of the principle, saw its potential, fought for its acceptance and brought it fully into satisfactory use.

The Ferranti Argus computer was built by an automation group, not a computer division. Argus had its origins in attempts to control guided missiles. It was designed for process control, rather than scientific analysis or commercial transactions. Contrary to the usual narratives of failure surrounding UK computers, Argus was a commercial success.

BLUE ENVOY

Blue Envoy was developed by Bristol Guided Weapons Department and Ferranti. The missile was made of stainless steel, equipped with double-delta wings and was slightly longer and faster than Bloodhound Mark 1. One anti-aircraft option was to fit a low yield nuclear warhead called Blue Fox. The Blue Envoy missile was tested at the scale-model stage, but the full-size missile never flew before it was cancelled in April 1957 as part of that year's Defence Review.

As the name implies, 'guided' missiles need to be carefully controlled, both in terms of direction onto the target and stability during flight. Firing a guided missile is a classic dynamic control problem, like a dog chasing an agile hare. But at least the dog only pursues the hare on the ground in two dimensions. A missile chasing a target aircraft has to deal with three dimensions, predicting the future position of the target from its current location and flight behaviour. Air density varies, so an optimum course may involve a near-vertical ascent to escape the drag imposed by the dense lower atmosphere, before heading off towards the target. To complicate matters, the earth is not strictly round, so allowance has to be made for this feature too.

During the initial command-guidance phase of flight, Blue Envoy received control signals from the ground. The first task was to get the missile on course after launch. The missile needed to correct its course so that it aimed in the right direction towards target interception. Final closure onto the target was by riding a narrow radar beam. But, before the missile can manoeuvre onto the target using directions from ground control, it needs to establish its angular error from the likely direction of interception. Circuitry was also needed to actuate the servomechanisms used to control the Blue Envoy missile during its prolonged mid-course flight.

Maurice Gribble developed digital logic circuits to code the angular position of the missile for onward transmission from the ground by a guidance beacon. The data would be decoded when it arrived in the missile and translated into control signals to steer the missile in the right direction. An obvious next step was to see if some of the actual controls on the missile itself could be undertaken digitally in response to these guidance commands from the ground. To this end, a special purpose digital computer was built to experiment with direct control of the servo-mechanisms.

BLOODHOUND 2

The concept of Bloodhound Mark 2 was invented in a company car as an urgent response to cancellation of Blue Envoy.

Use of digital computers for military purposes faced strong opposition and military deployment owes more to friendship, chance and technical genius rather than any high level decision to use the technology for defence purposes. Use of digital control on the Bloodhound 2 Launch Control Post (LCP) was due to a problem that could not be overcome using conventional analogue computing. As Derek Whitehead said 'I did it because I didn't think analogue would do what I wanted it to do'

Side note: The same situation arose later as a crisis on the analogue engine intake control system on the Concorde, where the Bristol GW team were able quickly to design and develop a precise digital system.

The guidance system of Bloodhound 2 used a continuous wave radar system which illuminated the airborne target. A radar dish inside the head of the missile picked up the doppler return reflected back from the illuminated target. Continuous wave radar had compelling advantages, including the ability to discriminate between targets at the same range and could detect moving targets amid the clutter of stationary objects which had very different frequency returns. It was less susceptible to jamming. Continuous wave radar is exacting, since it requires a very stable signal so that the missile can pick up the slight doppler shifts returning from the target.

Missile engagement, set up and launch was the task of the LCP which received incoming data such as bearing, elevation and distance of hostile aircraft from the Early Warning Radar via an operations room. The engagement controller in the LCP would track the assigned target using Target Illuminating Radar. The missile launcher would be moved to face the target and the missile receiver dish would be turned on where to expect the target after launch. Once the incoming reflections from the target were sufficiently strong, the computer would indicate a 'free to fire' message and the controller was free to launch.

Once it had been decided to fit a digital computer into the LCP other tasks were added for it to perform.

At some stage the firing sequence came to be initiated from the computer. There was a further problem of crossing targets. When the target aircraft is almost at right angles, the doppler drops towards zero and is undetectable as you cannot measure low frequency returns and the target disappears from the radar. So you need to pick up the target again once it has passed that point. The ground illuminating radar had a crude analogue servo for predicting a crossing target of this sort. But the Argus computer in the LCP was much better at predicting through this zero doppler point. The computer commanded scans if the zero doppler point was about to be reached in order to look for a reappearance of the signal; the longer the time without a signal, the bigger the scan. There was feedback from the computer to the illuminating radar.

So using Argus on the Launch Control Post for Bloodhound 2 not only solved a problem of accurate arithmetic but also left computation capacity for additional tasks.

A RADICALLY DIFFERENT APPROACH TO PROJECT MANAGEMENT

This account of development at Ferranti draws on interviews with the Argus inventor, engineers, builders, programmers and users. This approach gives a different perspective on the history of engineering and technology.

Here we look at individuals working as designers, developers, problem solvers and trouble-shooters, in small communities of practice characterized by group cohesion, easy exchange of technical ideas and a certain amount of gossip and scandal. These communities were ideal ways to share experience and tacit knowledge about the problem in hand.

This practical focus downplays the role of senior managers and government officials. Rather, the computer emerges among gifted designers and practitioners, helped along by a certain amount of bootlegging, a great deal of engineering verve and enthusiasm, and some gifted women programmers. The focus of this narrative stands in contrast to archive-based treatments of computer history which emphasize the role of senior managers and government R&D institutions.

TODAY'S SITUATION

- I was responsible for creating the Bloodhound 2 Weapon System, and the team have done me the honour of making me Honorary President of the Bloodhound Missile Preservation Group.

- As such I can see that the different organization is needed in other fields of product innovation which conflict with existing widespread perceptions by senior management - in particular Cost Engineering.

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REFERENCE
1. Aylen, Jonathan. Manchester Institute of Innovation Research, University of Manchester, "Bloodhound on my Trail: Building the Ferranti Argus Process Control Computer."