Cruise Control

Cruise missiles are a controversial subject, but they contain some interesting computer technology — such as bubble memory — which will soon be appearing in home computers

When Neil Armstrong took his one small step onto the surface of the moon, it was largely due to computerised guidance systems. Of course, interplanetary rocketry relies on very precise engineering, but without computer hardware and software it would never be possible to perform positional calculations either fast enough, or with sufficient accuracy, to allow one object to engage with another at a vast distance — even an object as big as the moon.

When one considers current military requirements that call for the placement of warheads to within 20 or 30 metres (70 to 100 feet) after a flight across a continent, then the scope of data processing power needed to perform the calculations becomes enormous.

Early military experience showed that the fundamental problem with missiles was that once fired, no correction was possible. The first major advance came with the development of simple guidance systems that were able to judge where the rocket was in relation to a point on the earth's surface (the launch site) by deducing how far it had travelled, and in what direction. But even a first-class modern system of this type will be prone to significant error.

Another, and more accurate, method uses satellites in geo-stationary orbit as reference points. The main drawback to these systems is that the flightpath of the missile — and probably its target — are deducible by the enemy very soon after launch, given the capability of modern over-the-horizon radar systems. To combat this vulnerability, the ideal military requirement was for a low-flying missile with a small radar cross-section that could actually decide for itself the course it would fly to its target. And so the Cruise missile was born.

The Cruise missile constantly updates its position by analysing the contours of the ground over which it is flying. This is done by matching a succession of height-above-ground readings, from an extremely accurate radar altimeter, with a contour map of the terrain stored in an on-board bubble memory.

This system, developed by McDonnell Douglas, is known as TERCOM (TERrain COntour Matching), or DPW-23. Each missile has stored in its bubble memory some 25 'route profiles' that it compares with the terrain it is passing over. However, there are drawbacks to this. For example, the system is not usable over water as that has no permanent features. It is also not reliably accurate over sand desert, where the terrain is in constant motion. Neither, one suspects, is it accurate in the depths of a North European winter, when the terrain will be significantly altered by the large seasonal snowfalls.

Cruise does not use this guidance system from the moment of launch. It remains inertial while the missile flies at altitude in friendly airspace. Once it is vulnerable to attack from the air or the ground, it dives to within 15m (50 ft) of the ground for its flight over enemy territory. Even though it may be up to a kilometre (1,100 yds) off course at this point, it is predicted that it will be sufficiently close to one of its 25 mapped routes to be able to relocate itself precisely.

When the missile nears its target it turns on a Terminal Correlator Unit which contains — once again in bubble memory — a detailed digital picture of the target area as it would be seen from an on-coming missile. Tests have shown that this system is likely to be accurate to within 18m (60 ft), after a flight of some 2,800km (1,750 miles).


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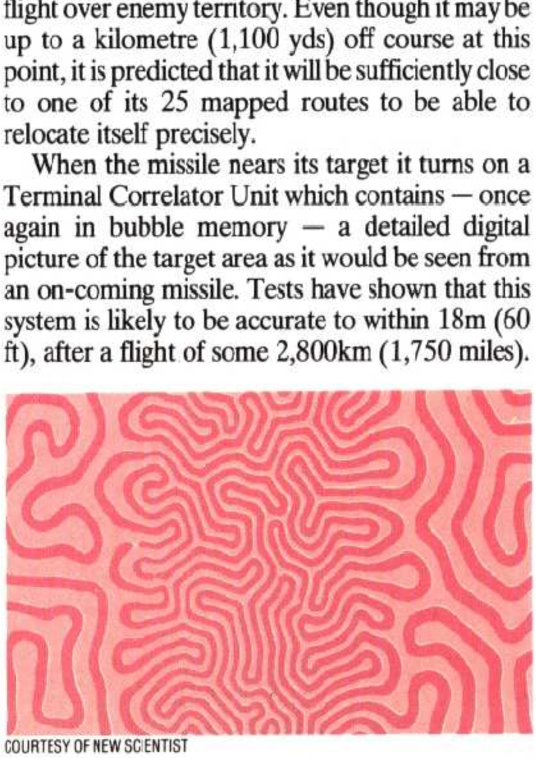
Self-Seeking Missile
The General Dynamics 'Tomahawk' Ground Launched Cruise Missile is 6.40m (21ft) long, and weighs less than one and a quarter tons (1,200kg). Fired from a tube mounted on a mobile launcher, it starts life as a conventional rocket, but soon deploys small wings and settles down to low-level flight powered by a remarkably small and compact turbo-fan jet engine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Bubble, Bubble
In bubble memories, 'bubbles' of magnetic force are created to form a '1', and not created to represent '0', on a tiny chip of garnet. The advantages are the packing density — currently one million bits, or 128 Kbytes per chip — and no loss of contents when the power is turned off. However, bubble memories react considerably more slowly than conventional RAM