Lessons of Warfare

There were hundreds of kilometers of tunnels connecting villages, districts, and even provinces. They held living areas, storage depots, ordnance factories, hospitals, headquarters . . . The tunnels evolved as the natural response of a poorly equipped and mainly local guerrilla army to mid-twentieth-century technological warfare . . . by becoming an army of moles pitched against armies winged into battle by helicopter, the . . . guerrillas . . . protracted the war to the point of persuading the United States that it was unwinnable.
. . . the very reverse of high-tech weapons development took place within the tiny ranks of the tunnel rats. They had to relearn the whole business of . . . face-to-face combat . . . without weapons superiority . . . home-based scientists were only too happy to produce new weapons systems, many of which turned out to be useless.

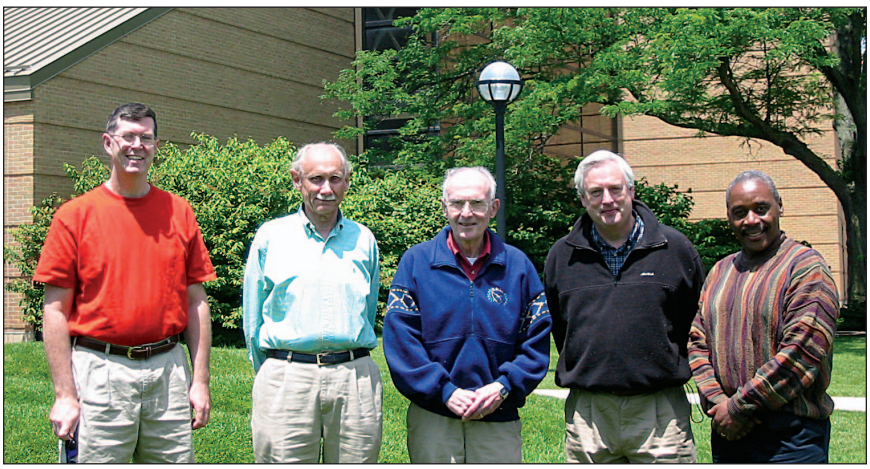
—*"The Tunnels of Cu Chi" by Tom Mangold and John Penycate*

I've noticed that the source of many disagreements between rational individuals can be understood through the following principle: the idealist argues for what should be, while the realist argues in terms of what is. Although this model is simplistic, I'll take the realist point of view and examine the role of control systems technology in fighting wars and maintaining security.

This magazine rarely publishes articles about military systems and weaponry but perhaps the topic should be given more coverage. In fact, there are few applications that make more intensive use of control systems technology. Weapons systems detect and acquire targets and guide projectiles to hit the enemy with destructive force. This ability is as essential for the bow and arrow as it is for the cruise missile. And control engineers play a role in virtually every aspect of weaponry. We develop ideas and technology to find and track targets, point guns with accuracy, and steer missiles to a successful impact. Whether the shot is fired from a Humvee, a battleship, or an airplane, weapons systems rely on the principles of control. On the receiving end, control technology defends by evasion or by hitting an incoming missile with an outgoing missile. These tasks are unimaginable without control engineering.

The ability to shoot farther and more accurately than the enemy, as well as the ability to see farther and more clearly, is crucial for fighting a war, since these abilities determine the ratio of losses. In fact, because of finite resources—people, weaponry, and money—attrition plays a role in every conflict. To some extent these resources are interchangeable: Money buys weaponry and pays for soldiers, while dependence on fewer soldiers implies the need for more sophisticated and thus more expensive weapons. The United States military is increasingly moving in that direction. Using control technology for remote or autonomous operation, future military aircraft will have fewer pilots, reducing the need to place pilots' lives at risk.

As the United States learned in Vietnam, however, advanced and sophisticated technology has not



University of Michigan control engineering faculty from the Aerospace Engineering Department enjoy a sunny day outside the FXB building. From left to right are Editor-in-Chief Dennis Bernstein, Elmer Gilbert (emeritus), Bob Howe (emeritus), Harris McClamroch, and Pierre Kabamba.

always provided the expected edge. Although the awesome power of the B52s was blunted by Soviet-supplied SAM missiles and their crude but effective tracking ability, the United States controlled the skies. But the ability to control the land was thwarted by a tunnel system of shocking ingenuity. This system allowed the Viet Cong to move freely under the feet of U.S. troops and harass a powerful army to a standstill. In addition, the tunnel system allowed the Viet Cong to scavenge the detritus of a well-equipped army by night and return to tunnel workshops to fashion ingenious weapons by day.

Ubiquitous booby traps, hidden compartments, and water filled U-traps connecting narrow tunnels made military technology impotent. The raw courage of soldiers willing to crawl through total darkness probing for trip wires and engaging in tunnel firefights was the only effective approach to countering this low-tech means of attack and evasion. For the Viet Cong, building and living in the filth and darkness of tunnels for years was a hardship that is impossible for us to conceive of. We learned that an enemy with infinite patience, determination, and the ability to tolerate suffering can wear down our will to wage war.

More recently, we learned of a new threat, namely, the ability of an enemy to usurp our own technology and use it against us while substituting human lives for control technology. And we continue to learn that much of modern warfare is a political contest, where civilian casualties and collateral damage hurt our image in the eyes of the world.

Control technology is powerful and essential to warfare, but it is not foolproof. Our sensors and information systems can be deceived, and our most sophisticated technology can be brought down by crude and cheap weapons, delivered with determined ingenuity. Ultimately, our security will best be preserved by skillful, vigilant, and courageous humans, aided by advanced technology but not replaced by it. A realist sees these lessons as unavoidable.

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