The reason for militarised C^3I equipment

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To counter the threat of a numerically superior and technologically sophisticated enemy with both advanced conventional weaponry and nuclear capability, automated command, control, communications and intelligence (C^3I) systems have been proposed as a force multiplier.

A dramatic increase in battlefield effectiveness will be achieved by the enhanced responsiveness of highly mobile, even if numerically inferior forces, positioned at the right place and the right time in sufficient strength to effectively deal with the enemy in either defensive or counter-offensive actions. To accomplish this deployment, a commander must have both timely and accurate information on both the condition and potential intentions of the enemy, and the status of friendly forces. An automated C^3I system can clearly aid the commander in this process.

Intelligence or, broadly, information, is *the basic input* into the system and must be available *before* any C^3 I functions can be performed. Information will first be gathered from a wide variety of sensors, informants, and other sources remote from the command centre. This information must be processed and stored in a readily accessible database. But before any of these processes can take place, information must be delivered in usable form to a collection point. This brings up the second element, that of communications.

The increase in battlefield effectiveness is a direct function of the timeliness of the information available to the commander which, in turn, is dependent on the speed and reliability of communications. Once the information is available in the database, the joint process of command and control can begin. Sometimes referred to as C^2, it is defined in the Joint Chiefs of Staff Publication 1 as "The exercise of authority and direction by a designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of *personnel, equipment,* communications, facilities, *and procedures* which are employed by the commander in the planning, directing, coordinating, and controlling of *forces and* operations in the accomplishment of the mission."

The effectiveness of a commander in performing these tasks is contingent on the reliability and accessibility of the information database. There are two very important aspects to a tactical

The tactical computer terminal (TCT) AN/UYO-30(A).

database architecture; replication and distribution.

Because of the importance of the database relative to the C^2 function, contingency procedures must be available in the event of the loss of the database due to site mobility, equipment malfunction, or enemy action. The command database thus must be replicated at one or more sites in addition to the commander's location. Subordinates who are participating in the C^2 function are spread over several echelons and a number of individual sites. This staff requires constant access to varying portions of the command database. A distributed database which must be continuously updated with current information puts an enormous load on communication. Thus in the design of a C^3I architecture, the trade-off between database requirements and communications load is a very important task, with database integrity and communications reliability being key determinants of system effectiveness.

Avoid total dependence

Although a fully functional automated C^3I system allows for an enormous increase in battlefield effectiveness, there can be a significant risk in total dependence on such systems. In case of total or partial failure of the C^3I equipment, the various staffs will be forced to resort to voice communication coupled with the slow manual operations used before automation. Because of a lack of practice and unfamiliarity with manual operation, the personnel could be less effective than they are today. To minimise this inherent risk, the first line equipment must be as reliable and as survivable as possible. To that end, let us examine the case for militarisation in equipment design.

A lack of the effectiveness of a C^3I system that is so vital to successful operations may be worse than that of no system at all. Only fully militarised (environmentally qualified) hardware can withstand the rigours of a tactical battlefield environment that includes attacks, weather, temperature, and the shocks associated with abrupt movement. But there have been recent trends that suggest that something other than fully militarised equipment might provide an acceptable solution. It is easy to see how such a conclusion might be reached. The growth in the use of automatic data processing in the commercial and industrial world has been phenomenal. The advent of the workstation and even more so, the personal computer, have allowed people in all walks of life access to high processing power. The functions performed by a network of interconnected workstations in a commercial or industrial environment are seen as being analogous to the basic requirements of a tactical C^3I system. Indeed, some of the database and display software may be directly applicable. For these reasons, a number of PCs have found their way into military organisations at various levels, and sometimes even into tactical mobile units on an experimental basis. Fully militarised equipment is considerably more expensive as to an acquisition cost (but not necessarily on a life cycle cost basis) than a commercial unit of equivalent processing power. This has led some to suggest that commercial-off-the-shelf (COTS) equipment (or at least ruggedised* versions thereof) is adequate for actual tactical operational situations. It should be noted that ruggedised COTS designed primarily for factory environments is available. These units, however, fall far short of the reliability implied by a *fully* militarised capability. Although there is some functional similarity between a militarised and a commercial C^3I systems, there is a vast difference in legitimate expectations as to the longer term battlefield effectiveness of these two diametrically opposed concepts.

The Tactical Computer Terminal (TCT), AN/UYQ-30 and AN/UYQ-30(A) designed and manufactured by the Librascope Division of the Singer Company, is a fully militarised, compact, general purpose data processing, display, and communication terminal for Army field use at all echelons in a variety of highly mobile and semi-fixed battle area situations. It facilitates the collection, generation, review, analysis, and distribution of tactical information both in textual and graphics modes. It consists of a display-keyboard processor, line printer/plotter, a choice of bulk data base memory devices with up to 100 megabytes of storage, a power supply and a magnetic tape recorder/reproducer.

Equipment cornerstone

The TCT as deployed by the US Army in the Manoeuvre Control System is the keystone item of equipment in one of the five battlefield functional areas which make up the tactical architecture of the US Army C^3I system.† These battlefield functional areas (sometimes referred to as the five points of the star) are interconnected via tactical digital data communications systems and controlled by the commander through exercise of Force Level Control, a specialised software application designed to support the fighting forces commander and his staff. This integrates the information from all battlefield functional areas and outputs to the commander the critical information required for his decision making.

The TCT is fully militarised and has been completely qualified to US Military Standards. COTS (even ruggedised) cannot meet the wide range of environments specified herein, and clearly, equipment which is not functioning has zero effectiveness. As the US Army may be required to fight under a wide variety of climatic conditions, the most serious effect of these is the wide range of temperatures encountered as a function of geographic and seasonal variations that far exceeds the safe range for COTS operation (normally 0 to +50°C). This problem manifests itself due to ambient air temperatures, solar radiation, and induced air temperature in storage and transit conditions.

Extra operational difficulties

In order to have COTS survive and operate in this environment it is necessary to provide external support. This support must be in the form of shelters with air conditioning and/or heating. This may solve the problem for the first two but there is no practical solution to the last, since military transport and storage may involve no temperature control and very rough handling. Even when protection is possible, a very severe logistic penalty is paid for the luxury of shelters, fuel and facilities for heating, and fuel and extra generator capacity for air conditioning. There is an additional logistic multiplier effect since not only must the facilities and fuel be provided, but additional specialised transport may be required. Mobility, which is of prime concern in battlefield effectiveness in modern high speed warfare, is greatly reduced by the inclusion of this additional special baggage.

In addition to the logistic penalty that must be paid for temperature control, another serious penalty will result. This is a dramatic increase in the vulnerability of the system. C^3I installations, because of their potential as force multipliers have become highly valued targets. Measures must be taken to prevent the detection of the C^3I site. Unfortunately, all of the support equipment required for temperature control (shelters, generators, air conditioners, trucks) potentially incrase the radar, visual, thermal and acoustic signatures of the site, making it much more susceptible to detection and counter-measures.

Physical protection of COTS from many of the other environmental effects can be accomplished more readily than the protection against temperature.

*Ruggedised implies meeting some intermediate level of environmental qualification between commercial standards and full military specifications. The real issue is what level of ruggedised in specific terms can be deemed cost-effective?

†The other battlefield functional areas are air defence, combat service support, intelligence/electronic warfare, and fire support.

However, this protection cannot be achieved without additional penalty. The usual approach is to use an oversized transit or combination case and mount the COTS on isolation mounts within it. However, the penalty that must be paid is that of a significant increase in volume and weight. This brings about attendant logistic and special handling problems. There is also the problem of storage (and potential loss) of the transit case/ covers while the equipment is in use.

There are areas other than environmental in which fully militarised equipment like the TCT is far more effective than COTS. One of these areas is in the soldier/machine interface. Although, COTS is certainly designed to be user friendly, it should be noted that a commercial user and his working environment is significantly different from that of the battlefield. The user in an office environment may have a much higher level of education and sophistication that the soldier in the field and certainly is not as exposed to weather. The TCT was designed with these factors in mind as well as the fact that the field user will be working under the most severe mental stress in a completely hostile environment.

A specific area which has great impact on system reliability and therefore battlefield effectiveness is that of cables and connectors. Cables and connectors are the weakest link in any electronic system, since they are most susceptible to damage via dirt, corrosion, and rough handling. High mobility requirements impose almost constant assembly, disassembly and reconfiguration of the equipment. The TCT has fully militarised A/N connectors located for easy accessibility at either the front or the side. Commercial connectors are usually very reliable in soft environments, but cannot stand up to the rigours of constant disconnection and reinsertion in any kind of environment. Furthermore, most COTS have their connectors on the rear, inconvenient to access when in a military vehicle, or shelter.

Tactical C^3I is deployed at all echelons from battalion to corps and above. The environmental and mobility requirements clearly differ at each echelon level, in general becoming progressively more benign at the higher echelons. There are some installations at certain echelons where sufficient protection is provided so that the risk of deploying COTS is diminished. But even under the most ideal conditions, a residual risk remains since protection against some environments such as extended range nuclear effects cannot be provided. If cost factors absolutely force the consideration of COTS, then a cost-risk analysis must be performed to determine in which area it will be least vulnerable.

Regardless of echelon of deployment, range from the MLR, or protective sheltering or concealment, all command posts and communications centres are more or less vulnerable to long range or air delivery of ordnance. Since communications is the most vital link to survivability, its continued operation during or after the shock of nearby bombardment is imperative. If COTS is rendered inoperative to any serious degree, the time to repair or replace it may be unacceptable in terms of own or coordinate unit survival. The fundamental question is, "Can you *reasonably rely* on communications to be available and operable when you desperately need it?"

In conclusion, it can be said that the potential functional capabilities of modern ADP equipment and software utilised in a C^3I system can greatly increase the battlefield effectiveness of a commander in a tactical situation. If, however, the equipment planned to provide this functional capability cannot survive without excessive external protection and support, the attendant decrease in battlefield effectiveness resulting from penalties in logistics, availability, vulnerability and mobility will reduce any potential gain in effectiveness to zero or less. Thus, the additional acquisition expense entailed in fully militarised equipment is well worth the cost. □

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