INFORMATION HANDLING IN AN ARMS CONTROL INSPECTION AND VERIFICATION ENVIRONMENT*

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On 18 April, 1963, the United States tabled at Geneva an outline of a treaty on general and complete disarmament. It is this document and its subsequent modifications that provide, and will provide, the bases for planning of arms control inspection and verification systems. It must be emphasized, however, that an actual system configuration will be predicated on agreements reached at the conference table and on coordinated international technical design criteria. The operational and system concept discussed in this paper, therefore, may have little, if any resemblance to an actual operating system, whose resultant design would be based on international political and technical accord. Nonetheless, it appears certain that automated information handling will play a major role in any disarmament program.

Apart from any political considerations, the functions and the technical elements of an arms control inspection and verification system would constitute a command and control environment not unlike the National Military Command System (NMCS). The functions of data collection, data absorption, identification of significant information, analysis, decision-making and feedback are basically the same for both systems. Assimilation of large masses of data is a common problem, as are requirements for complex and extensive communications systems. Real time operation may not be as critical in an arms control inspection and verification system as in the NMCS; however, the lack of ability to communicate between nations and individuals participating in arms control agreements may be a greater obstacle than in the NMCS. Whereas detailed requirements for the NMCS are at least defined, specific operational and certain technical requirements for arms control are still to be determined.

Despite the lack of specified requirements, we can, with a degree of certainty, conclude that systems for arms control should have the capability to perform the following functions:

1. Verify the agreed destruction, reduction, declared levels of arms production, force levels, facilities, and stockpiling of military materials, and the incremental changes in these levels as disarmament proceeds.
2. Detect, identify and confirm illegal production stockpiling research and development, and testing or deployment of arms.
3. Detect illegal movements or shipment of arms or forces out of or into specified zones or to other countries.

The functions of command and control, as related to the arms control problem, specifically

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*The comments expressed in this paper are those of the author and do not necessarily reflect the position of the Arms Control and Disarmament Agency.
include the gathering of information in and about an area; the storage and subsequent analysis of this information for meaning and intent; identifying changes against an established data base, and finally, to interpret the significance of these indicators and their complex inter-relationships to the environment being inspected. Within this system, the information handling subsystem must accept, filter, store, collate, analyze and display a myriad of data on which command and control decisions can be based.

In examining the functions of this system, it is reasonable to conclude that it is designed to detect illegal and clandestine operations very akin to a gigantic intelligence system. However, we must not lose sight of the fact that ideally many nations will participate in the design, construction, operation, and maintenance of this system; therefore, the security aspects normally associated with intelligence activities will not apply. A national requirement by participating countries for unilateral backup will undoubtedly be necessary during the early phases of disarmament or until a level of mutual confidence is reached. The discussion of such systems is beyond the scope of this paper.

The single major and governing factor in the design of a command and control system for arms control is the degree of access which the host country will tolerate. If unlimited access could be assumed, the need for any command and control system for disarmament might be questionable. Certainly the need would be progressively reduced once the intention of participating countries to abide by the terms of the treaty was established. It is highly unlikely that any country will agree to complete access; therefore, for the purpose of this paper, it has been assumed that disarmament agreements will include a degree of access that will permit effective inspection. It has also been assumed that this access will be for the purposes of ground and airborne inspections.

Let us now examine the rudiments of an arms control inspection and verification system and its methods of operation. The concept which has been developed envisions the use of three subsystems integrated by a command and control communications complex. The subsystems include ground inspection, airborne inspection, and a data handling capability. Essentially, these subsystems will perform as follows:

Airborne Inspection

Airborne inspection data will be collected by aircraft flying at altitudes up to 40,000 feet and above, equipped with a variety of sensors. Low altitude and/or limited area coverage will be accomplished by aircraft also having a multisensor capability or helicopters with selected sensors and observers.

Ground Inspection

Three types of ground inspection teams will be required: (1) teams for inspection of production and deployment of armaments; (2) teams for inspection of transport facilities, such as rail centers, highway terminals, airfields, ports and harbors; and (3) teams for investigation of clandestine activities, spot checking, etc. Inspector capabilities may be augmented with radar, photographic equipment, and infrared sensors, magnetometers, spectrophotometers, Geiger and Beta counters, chemical, physical and biological instruments and communications monitoring devices.

Data Handling

With expected acquisition of data from a combination of ground and airborne inspection teams, there is the complex task of transforming these data into information of a kind that can be used as a basis for effecting the functions of inspection and verification. This is an information handling and analysis problem which calls for a proper mix of machine processing techniques and human capabilities in a system that can perform the prescribed functions efficiently and at a reasonable cost.

Data collected by aerial and ground inspection teams must be accepted, translated if necessary, reduced and processed at the data handling center. Both image and non-image data are received from each mission necessitating reduction, interpretation, classification and insertion into the appropriate files. Data from
each mission are correlated and compared with data already stored and confidence factors established. In this manner, files would be continuously updated, enlarged, and confidence factors revised.

To fully appreciate the magnitude of the data handling problem, an examination in a greater detail of the system components would be helpful. Let us first examine the operational aspects, beginning with the sensors and ending with the conversion of inspection data into machine language. This is shown in Figure 1.

![Figure 1](image-url)

The sensors listed in Figure 1, under airborne and ground inspection, are only a few of the technical equipments which will possibly be used in an actual arms control situation. If we assume an inspection area the size of the U.S. or the U.S.S.R., the amount of data which these devices can collect, even with limited access, defies processing and assimilation without electronic data processing assistance. Add to this the socio-political data which are available in tremendous quantities and the task of data handling becomes almost insurmountable. One might ask why this latter data is used if it complicates an already complicated situation.

Two reasons should help to answer this question. The first reason is that a vast amount of information has been accumulated over the years and is available for the asking from sources such as the Department of Commerce. The second reason is that electronic data processing provides a technique for analyzing the data and presenting it in a meaningful fashion for arms control and disarmament use. These socio-political considerations such as economic, political, social and statistical data, when interpreted in an arms control and disarmament context, could provide satisfactory substitute methods for physical inspection of a country. It is our plan to determine the validity of this assumption.

We have in our system concept reached the sensor output stage where we have very large quantities of data in many forms. Some of this data is readily converted into machine language; the majority, however, cannot be readily converted. In the case of some ground and airborne sensors, it must first be processed into raw workable data, and the pertinent or desired information extracted for further man-machine processing. Other sensor outputs could be converted to digital form and sent directly to the data processor. In the case of statistical data or reports, a major problem of cataloging and filing is encountered. All of these problems can be summed up in one word, "interface."

Precisely what are the interface problems in a system such as we are considering? Take photographic techniques as an example. The use of light sensitive film as a sensing means will perhaps provide one of the most meaningful inputs to an arms control inspection and verification system. Yet one of the major interface problems with which we are confronted is in this area. How is the film read and analyzed and the data fed into the data handling subsystem? Do we use a man as the interface or can we automate the operation to give us a real or near real-time approach? Side-looking radar presents a similar problem, as do other sensing techniques we have mentioned.

These problems are being studied by the Arms Control and Disarmament Agency. The difficulties are recognized. Continuing research should, however, provide solutions to these problems. They have been a problem area for many years in military systems for which large sums have been expended in searching for a solution. We feel our problem in this area is especially important because we would be hard put to recommend an automated operational
system should such a system be required in the near future.

Figure 2 is a simplified diagram of a concept for an Arms Control Inspection and Verification System including the command and control function. We have indicated in this diagram the interface and data conversion as separate functions. In an actual system they could or possibly would be combined. For simplicity, many important data processing steps have actually been eliminated from the diagram. These include storage of data before collation and analysis, updating of the data base and indicator files, the means for coordination of activities between the major elements of the system and the current operational file which would be associated with the collation and analysis process.

With the exception of the data base and indicator files, the remainder of the system operates in a dynamic environment changing constantly as data is updated and corrected. The data base and indicator files are changed only after a thorough analysis and study of data to be inserted. The data base consists of information collected over prolonged periods of time and is filed in such a manner that new data collected by the sensors can be compared with information already in the file. Examples of data in the data base might be steel production figures over the past 50 or so years, salient features of the trans-Siberian Railroad and scientific and technical data extracted from technical papers, publications, etc. The data base is also updated with information from the sensor system as these data reach a certain confidence level. There is a continuing updating and inputting to maximize the confidence level.

The indicator file is an up-to-date consolidation of information required for the identification of the various types of military bases and industrial complexes. It differs from the data base in that the information it contains is general in nature, whereas the data contained in the data base concerns a specific site, area or activity. In other words, the indicator file contains the salient descriptive features necessary to identify a missile site, nuclear power plant, Army base or similar facilities.

After the data obtained from the sensor has been converted to machine language, the process of collation and analysis begins. First, all of the data obtained from the sensors in and about a specified area is processed and any priority-type data made available to the decision makers. The next step is to compare current sensor data with information contained in the data base or indicator files. In this process, an attempt is made to determine if a change in a normal or agreed to situation can be detected. Using previous examples, steel production shows an increase of 13 percent, a new railway spur is being constructed on the trans-Siberian Railroad, or a large number of nuclear physicists are being transferred to a new facility being constructed in central Russia. These changes may not in themselves be violations of any treaty or agreement, but they could indicate a clandestine activity in operation or in the early phases of a buildup. It should be emphasized at this point that the purpose of the information handling system is to detect change and not to categorically state that a violation has been committed. That a violation has occurred is determined by the decision makers.
who could be inherent within the system, or
the facts surrounding a changing situation
might be sent to an International Disarmament
Organization where a decision would be made.

When a change has been identified, the per­
tinent facts will be appropriately displayed to
facilitate the decision-making process. For ex­
ample, we might display all of the steel produc­
tion figures for fifty years. These could show
a gradual increase during normal times with
peaks for World War I, World War II, and
Korea. However, now we note a sharp increase
in production with no readily available ex­
planation. Our industrial data do not indicate
any vast expansions and no major housing or
other commercial projects are being under­
taken. Display of this data can be made so that
a decision concerning the criticality of the situation
can be reached. The decision makers may
ask for a reassessment of the facts, send out
inspection teams in an attempt to verify the
facts directly, ask the inspectee country for an
explanation or perhaps verify or discredit the
information through the unilateral information
sources available to members of the IDO.

Other more complicated situations could be
cited such as a combination of the construction
of a railroad spur to a remote area, increased
steel production, development of large housing
communities in the vicinity of the railroad spur,
and movement of scientists and engineers to
the area. This data alone indicates a major
change from a normal situation, although not
necessarily establishing the fact that a violation
has been committed or construction of a clandes­
tine activity is underway. It is interesting
to note, however, that the data could have been
obtained from a variety of sensors and only
through collation and analysis was it possible
to determine that a significant “change” in a
geographical area was taking place.

While the foregoing are relatively simple ex­
amples, there could have been hundreds of other
bits of information made available through the
system which could serve to describe the
activity in relatively minute detail. It should be
emphasized that if this system were manual in
character, only limited data could be used with
consequently reduced confidence placed in the
conclusions; however, with electronic data
processing the source of data used can be
extended many times and thereby add credence
to the apparent discovery of a violation. There­
fore, the confidence factors assigned to a chance
detection is dependent to a large extent on the
amount and numbers of sources of information
which are used in the collation and analysis
function.

It is recognized that the above is a very gen­
eralized treatment of the data handling and
command and control functions of an arms
control inspection and verification system. The
approach to an ultimate system, aside from
political factors, must evolve from comprehe­
sive studies of the problem and experience
gained through the conduct of actual field tests
and experiments. It is the field testing area with
which Project CLOUD GAP is most concerned.
Research, concept development and studies will
not attain the confidence level that a well de­
signed, executed and evaluated field test can
provide.

It is emphasized that, for the purpose of arms
control and disarmament, a system such as that
described does not exist nor has its practicabil­
ity been fully investigated. Consequently, the
scope of this paper has been purposely confined
to a limited treatment of both requirements and
operational objectives. We are, however, cer­
tain that access, the requirement for real or
near-real time operation, sensor capabilities
and interface problems all will have a major
effect on the systems design.