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OBJECT ORIENTED SIMULATION FOR THE U.S. ARMY GRAVES REGISTRATION SERVICE

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ABSTRACT

Object oriented languages have been used successfully in such areas as simulation, systems programming, graphics, and Artificial Intelligence. Object oriented programming has become increasingly popular in the 1980's. Smalltalk[TM] is an object oriented language developed by Xerox, that has features particularly suited to simulation.

The US Army Quartermaster School, in 1984, commissioned the Ballistic Research Laboratory to perform a study of the Graves Registration (GRREG) Service. The thrust of the study was to evaluate the GRREG requirements of the future battlefield and evaluate the ability of the GRREG system to meet these requirements. A large computer simulation was written in Smalltalk in order to perform the analysis.

The GRREG services are best described as a network of queues, consisting of several hundred individual queues that are interconnected either in series or in parallel. The network will be described in three levels of detail, with the basic level consisting of the individual task queues, the intermediate level consisting of the three types of collecting points (initial, intermediate, cemetery), and the top level showing the flow from one collecting point to another.

The recommendations of the study are intended to provide the Logistics Community a direction for changes in GRREG doctrine, procedures, and organizations. Those recommendations have been accepted by the Army. The BRL has performed several follow up studies using the Smalltalk simulation, and has ported the code to the US Army Logistics Center for use on their machines.

1. INTRODUCTION

This paper describes a simulation methodology developed by the US Army Ballistic Research Laboratory (BRL) which was used to analyze the capabilities of the US Army Graves Registration (GRREG) Service. The simulation was written in Smalltalk-80[TM] , which is an object oriented language developed by Xerox.

In 1984, the US Army Quartermaster School (QS) commissioned the BRL to conduct a GRREG study. The GRREG program provides for recovery, collection, identification, and disposition of the remains of US personnel when the prompt return of remains to the continental US is not possible. The thrust of the BRL study was to evaluate the GRREG requirements of the future and analyze the ability of the GRREG system to meet these requirements. The study provided 1) a base line analysis of the ability of the present system to handle remains, and 2) an analysis of several alternatives, including changes in force structure, equipment, and GRREG procedures.

The recommendations of the study were intended to provide the Logistics Community a direction for changes in GRREG doctrine, procedures, and organizations. Those recommendations have been accepted by the QS, the US Army Training and Doctrine Command (TRADOC) , and by the Department of the Army. The BRL has performed several follow up studies using the Smalltalk simulation, and has ported the code to the US Army Logistics Center for use on their machines.

2. OBJECT ORIENTED PROGRAMMING

Object oriented programming has become increasingly popular in the 1980's. Object oriented languages have been used successfully in such areas as simulation, systems programming, graphics, and Artificial Intelligence. Smalltalk is an object oriented language, developed by Xerox, that has features particularly suited to simulation.

The roots of object oriented programming can be traced to Simula (Dahl and Nygaard 1966), a simulation language developed by Sperry Rand Corporation. Although other systems have shown some object oriented tendencies, the explicit awareness of the idea, (including the term "object oriented"), came from the Smalltalk effort at Xerox (Rentsch n.d.). The language Smalltalk (Goldberg and Robson 1983) is the first major interactive, graphic based implementation of object oriented programming. Many key concepts of object oriented programming can be seen in a variety of other languages today.

The common theme in object oriented languages is objects. Objects possess properties of procedures (functions, subroutines) and data since they perform computations and store information. This dual role contrasts with procedural languages such as C, Fortran, and Pascal which separate procedures from data.

Objects communicate by sending messages to other objects. When an object receives a message, it typically performs some action. The action might include numerical computations, storing or updating local information, or sending further messages. Message passing can result in a kind of indirect procedural call. Instead of calling a procedure to compute some value, one sends an object a message to perform some computation. The actions an object takes when it receives a message are called its method for that message. A method roughly corresponds to a procedure in ordinary programming languages.

Similar objects can be grouped to form an entity called a class. A class represents a generic kind of object, and can be thought of as a pattern or template for that kind of object. The classes themselves can be objects, and classes can be grouped to form a hierarchy of classes. With a hierarchy of classes, an object in one class can inherit the behavior of objects in its superclasses. This greatly simplifies the task of specifying how an object will respond to a message. Thus one can easily define classes that are "nearly alike", since inheritance eliminates the need for duplicating redundant information.

The idea behind data abstraction is that of defining a pattern or template for objects (Cohn n.d.). Objects can then be declared to be of a particular pattern and can inherit all the attributes and behavior defined by the pattern. As in Simula, such a pattern is called a class. (cf. the term package is used in Ada). Data abstraction allows individual objects to inherit the properties of the classes to which they belong.

Data abstraction localizes (and conceals) the details of an object. Conceptually, each class of objects resides on its own machine or computer, and objects communicate with each other only by passing messages. In effect, the objects partition the system's memory into disjoint blocks. Since all objects in a class have the same properties, the code for a class can be examined once to identify those properties. If a change is necessary, it need be made only once in the class definition rather than once for each object in that structure. Thus data abstraction localizes (and conceals) the details of generating and manipulating objects. The purpose of data abstraction is to permit the use of objects without any knowledge of the details of implementation.

3. GRAVES REGISTRATION SERVICE

The GRREG Program provides for essential search, recovery, collection, and disposition of the remains of deceased US, allied and enemy personnel in an area of conflict where the prompt return of remains to the continental United States is not possible. Disposition of remains is by burial in temporary military cemeteries, which are established in the COMMZ or Corps rear (see Figure 1). Current doctrine requires that units transport the remains of deceased soldiers to the nearest collection point. From there, GRREG personnel tentatively identify the remains and evacuate them, through intermediate collection points to the temporary cemetery. At the cemetery, operated by a GRREG Company, personnel remove personal effects from the remains for shipment to next of kin, and bury the remains.

Doctrine states that identification should be carried out as soon as possible after death and as close to the scene of death as possible. Remains recovered by GRREG personnel on a search and recovery mission are identified at the recovery site if possible. Early identification is felt to be the key to eliminating unknowns. Various identification media are used and doctrine prescribes what combinations are acceptable for positive identification. It must be remembered, however, that identification media which are used as sole source evidence of identification may be wrong. For this reason, current doctrine stresses the use of multiple identification sources to confirm the identity of remains. Thus a soldier's "dog tags" are generally not sufficient evidence for identification.

Current GRREG doctrine and procedures are general in nature and oriented toward the environments of past conflicts. Little attempt has been made in recent years to capitalize on current technology for identifying, reporting, and processing remains.

During peacetime, the GRREG system is not used. Peacetime manpower and fiscal constraints have forced the Army to place GRREG units in the Reserve Component and GRREG elements have been removed from many active unit tables of organization and equipment. Peacetime deaths of servicemen are handled by the current death program, which emphasizes civilian mortuary services and contract support. Because of this, very few GRREG personnel are in the active force, GRREG procedures have not been kept current, and problems posed by future battlefield environments have not been addressed.

4. GRREG QUEUING NETWORK MODEL

4.1 INTRODUCTION

For analytical purposes, the GRREG organization is best described by a network of queues. The network is rather complicated: consisting of several hundred individual queues that are interconnected either in series or in parallel. The network will be described in three levels of detail, with the basic level consisting of the individual queues, the intermediate level consisting of the three types of collecting points (initial, intermediate, cemetery), and the top level showing the flow from one collecting point to another. Figure 1 illustrates the queues and networks in the corps slice of the theater at this top level. Except for the remains of personnel who die in the COMMZ and are brought directly to the cemetery for processing, all remains in the theater will pass through a minimum of two collecting points prior to burial.

The GRREG queuing network forms a directed connected graph of arcs and nodes, with tokens passed along the arcs through the nodes. The tokens represent bodies or trucks, and each node represents a task to be performed on tokens and a queue where the tokens wait their turn for processing. The meaning of these terms depends on the level of detail in the network. At the top level, the nodes (circles) represent the collecting points, the arcs (lines) represent the connecting roads, and the tokens represent the trucks carrying bodies. At the intermediate level, the nodes represent individual tasks from the basic task list, the arcs represent movement from one task to the next, and the tokens represent the individual bodies at the collecting point.

Tokens are created by a generator (source) node. Each generator node has one arc leading to a task node's queue. Here the tokens wait their turn for processing. Examples of process (task) nodes are unloading trucks and taking finger prints. After the processing is completed the token travels on an arc to the next queue. This pattern is repeated until a final (sink) node is reached. An example of a sink node is a temporary cemetery plot. The sink node's queues hold tokens that represent the throughput of the GRREG services.

The description of the GRREG network will start at the top level with some basic definitions; then move to the intermediate level and a detailed discussion of the three types of collecting points; and conclude at the basic level with an examination of the various queue parameters.

4.2 TOP LEVEL NETWORK

The top level nodes are the collection points: a) Initial Collecting Point, b) Intermediate Collecting Point, and c) Temporary Cemetery. The arcs show the flow of remains toward the cemetery. The lower level networks define these nodes in more detail.

4.3 INTERMEDIATE LEVEL NETWORKS

The intermediate level networks represent the three types of collecting points (initial, intermediate, temporary cemetery). See Figures 2, 3, and 4. The nodes at this level represent the various tasks to be performed (e.g. unloading, assigning an evacuation number, finger printing, ...), and the arcs show the flow of bodies through the the collecting point. At the intermediate level, incoming tokens represent trucks full of bodies. Some of them start in the field, while others come from previous collection points. The trucks line up, and a pool of workers is assigned the task of unloading the truck. This pool contains several workers, with one worker on the truck, and the remainder (in pairs) on the ground to carry the bodies to the processing location, where the bodies receive an evacuation number (evac#) from one of the workers. The bodies do not physically move at this stage, but are added to the the identification and personal effects queue (ID).

Each collection point node has a limited capability to do processing, which is a function of the number of workers assigned to the collection point. Each task node requires one or more workers to perform the given task. When multiple workers are assigned to a task node, task characteristics determine whether the work is performed in parallel or in series. For example, tasks like loading (unloading) trucks need workers in pairs for each body to be loaded (unloaded) at one time, plus one or two workers in the truck. Tasks like identification require only one worker per body, while other tasks (e.g. filling out the convoy list), can be done by at most one worker at any given time.

Most of the arcs in the collection points and the temporary cemeteries are simple and represent serial task queues. The exceptions are the branching, joining, and forking of arcs at nodes, to be explained below.

Branching occurs when a token can be put on one of several queues after service. This happens, for example, after the body has received an evacuation number. If the body has already been processed through an initial collecting point, then the next task is to check the records to be sure there are no errors in processing up to this point. However, if the body has not been processed then the complete identification process must be carried out.

Forking occurs when a token is split and put on two or more queues. An example of this is can be seen at the temporary cemetery, where the holes in the ground are prepared while the body goes through final processing.

Joining occurs when a node waits for all parts of a forked token to arrive before processing continues. After the above holes and the final processing are completed, the body is ready for placing in the hole.

4.4 BASIC LEVEL QUEUES

The actual processing of bodies is done at the level of tasks, (e.g. unloading, evac#, id, pack, convoy list, loading). The nodes at the end of the arcs in Figures 2, 3, and 4 represent the basic tasks performed by GRREG workers. Some task nodes can have more than one worker at a time (e.g. n workers can perform the ID task on n bodies), while other tasks are restricted to one worker (e.g. the Evac task), thus only one body at a time. The hardest task nodes for worker allocation are the loading and unloading of the trucks, as described above, which consume two workers per body and one or two extra workers on the truck.

4.5 PARAMETERS FOR BASIC LEVEL QUEUES

The behavior of an individual queue is controlled by the choices made for a small set of parameters. These parameters will be examined as they apply to the various queues in the network.

4.5.1 ARRIVAL PARAMETERS The calling population (casualty workload) for the GRREG model is finite; limited by the intensity and nature of the battle and the troop population. The simulation was run well past the last battle (i.e. no arrivals) to determine the time needed to work off the backlog.

Some queues experienced only bulk arrivals, (occurring whenever trucks arrived with bodies). Other queues had no bulk arrivals, and some had both bulk and single arrivals.

The arrival rate for bulk arrivals changed daily and depended upon battle conditions and troop populations in the vicinity. For some queues, the arrival rate was the sum of the departure (throughput) rates of one or more previous queues in the chain.

4.5.2 SERVICE PARAMETERS Each queue in the network represents one of the tasks from the basic task list for the collection point. The service times for each task are independent and normally distributed. The number of servers (GRREG workers) at each service center changes throughout the simulation. A 'worker to task' scheduler assigns workers to individual tasks based on several factors including task priority and queue backlog. The worker stays only until task completion, at which time he is reassigned to either the same task or possibly another task. Thus tasks may get no workers assigned, or may get one or more workers.

4.5.3 QUEUE DISCIPLINE Queue discipline is first come, first served, and queue capacity is assumed to be infinite. However, for some excursions, balking was allowed at the truck arrival queues whenever the backlog reached a critical peak. The trucks would then proceed to the next higher echelon collecting point and try to join the input queue there.

4.6 TASK PRIORITIES

Workers are scheduled to tasks by a priority scheduling mechanism. The scheduler takes an idle worker and assigns him to a certain task based on task priorities to be discussed below. When the task is over, the worker is returned to the idle state, to await reassignment to another task.

For any idle worker, the scheduler tries a set of schemes to give the worker a task. The order of the schemes defines a priority, in that the first task found is the one assigned to the worker. The task priorities from highest to lowest are:

- end of the day
- trucks to be unloaded
- trucks to be loaded
- workers needing assistance
- tasks with no workers assigned
- tasks with a large backlog
- perform the previous task again
- random choice

The first priority is to check for the end of the working day. The next two priorities are to unload incoming trucks, then to load trucks. The fourth priority is to find "helpers" when needed. For example, some task might require two workers yet have only one worker currently assigned. Thus one helper is needed. The fifth priority is to fill tasks where no workers are assigned. Then if all tasks have workers assigned, the sixth priority is to reduce large backlogs. If there are none, then the seventh priority is to reassign the worker to the previous task. Finally, if the worker had no previous task, the last priority is to choose one at random.

Starting at the top of the list, a few of these tasks will be examined in more detail. The first scheduling priority is to check for the end of the work day. The scheduler checks for:

1. working over 7.5 hours in one day
2. the condition of 'lightsOut'

Current doctrine specifies a maximum of 7.5 hours per day per worker to be devoted to GRREG tasks. The condition 'lightsOut' occurs when the collection point is close to the front, and it is not safe to run lights at night. If either of these are true, then the worker goes to sleep. This requires that he also be scheduled for wakeup in the morning.

The next two schemes for tasking are to unload and to load trucks, in that order. If trucks are ready to be unloaded or loaded, then the scheduler tries to find workers to start unloading or loading them respectively. Scheduling workers for trucks is more complex than most other tasks, since it takes one or more workers on the truck to move a body to the tail gate, where pairs of workers can take it to the first queue for assigning evacuation numbers.

5. GRREG CAPABILITIES ANALYSIS

5.1 Introduction

This section describes the various scenarios investigated. These include the base case and 7 alternatives as listed below:

- base case
- LUPS I (Logistics Unit Productivity Study)
- LUPS II
- Double workforce
- Zero ID processing
- Evacuation
- Decentralized
- Contaminated Remains

The Smalltalk simulation model was run for the base case and for 6 of the 7 excursions. (As discussed below, the LUPS I excursion was not simulated.)

5.2 BASE CASE

The base case simulated the entire corps GRREG network under a standard TRADOC scenario. The GRREG organizations in the Corps were not able to maintain adequate performance in the base case simulation. Brigade collection points were unable to maintain a manageable backlog; only the lightly committed Brigades were able to complete processing of remains during the scenario. The heavily committed ACR (Armored Cavalry Regiment) had the worst collection point performance. Authorized GRREG assets in ACR are seriously inadequate.

Corps intermediate collection points were overstaffed and underutilized. Because of delay times and backlogs at forward collection points, most corps intermediate collection points did not start receiving significant numbers of remains until day 3 of the simulation. All corps intermediate collection points were able to maintain near zero backlogs for the entire simulation. Daily worker productivity for these collection points was consistently less than the forward collection points.

Because of poor performance and bottlenecks in forward areas less than half of the workload generated had been received by the cemetery after 20 days of simulation. Cemetery backlog gradually increased until it exceeded 400 remains at day 15. Cemetery performance was stable however, and productivity ranged between 1 and 2 remains per worker per day. The cemetery had almost completed processing of its' backlog by the end of the simulation. While a backlog of 400 remains may be unacceptable at a brigade collection point, it is not excessive at a cemetery in the COMMZ. Cemetery assets are adequate to meet projected workloads.

5.3 LUPS I

The LUPS I initiative eliminates the Corps and COMMZ GRREG assets and adds these assets to the GRREG Cemetery Company. These changes increase the workforce of the GRREG Company by 41%. The

GRREG Company assumes the functions of initial processing of remains and must operate two collection points for the receipt of remains.

The LUPS I initiative will result in a straightforward increase in cemetery capability with little adverse effect on collection point capability since corps and COMMZ collection points are underutilized. It is clear, however, that this initiative does little to relieve the backlog in the forward areas. For this reason the LUPS I initiative was not evaluated by simulation.

5.4 LUPS II

The LUPS II initiative takes LUPS I cemetery organization and adds the GRREG assets from the corps intermediate collection points This change increases LUPS I cemetery capability by an additional 9% but eliminates intermediate collection points. In order to fill in for the elimination of these assets in the Corps, the LUPS II initiative takes one half of the GRREG Company and assigns it to the Corps to operate a forward cemetery.

The LUPS II initiative eliminates redundant intermediate processing and underutilization of assets in the Corps, but it does not solve the bottleneck in the forward areas.

5.5 DOUBLE THE WORKFORCE

An excursion was conducted to explore the sensitivity of the collection point backlog to increases in the number of workers. This excursion used base case workloads and organization. The number of productive workers at each collection point in a division slice of the Corps was doubled. This resulted in a substantial reduction of backlog in all simulated collection points. The average reduction in total backlog (when compared with the base case) for the brigade/ACR collection points was 53%. The reductions in backlog and speedy processing of remains at brigade/ACR collection points resulted in a fast increase in the workload of the division intermediate collection point. The extra workers assigned to the division intermediate collection point, however, were able to complete the processing of all remains by the end of the excursion. Backlog at the corps intermediate collection point remained near zero for this excursion.

5.6 ZERO ID-PROCESSING

The sensitivity of backlog to ID-processing tasks in the collection points was explored with this excursion. Identification processing time was eliminated from the task list for a division slice of the base case. Base case workload and organization was used.

Elimination of identification tasks from the collection points also resulted in substantial decrease in backlog at all brigade collection points. The average reduction in total backlog (when compared with the base case) for the brigade/ACR collection points in this excursion was 57%. The average reduction in backlog for this excursion exceeded the reduction in backlog produced by doubling the workforce. All brigade collection points had completed processing of their workload within six days. While performance improved at the division rear collection point, backlog increased.

Backlog was increased at the Division rear as a result of quicker processing performance in the forward Brigades. Reducing ID task times will have the desired effect of shifting the workload to the rear areas, but unless intermediate collection points are eliminated or expanded with more personnel, a bottleneck will result.

5.7 EVACUATION TO HIGHER ECHELON

In practice, most GRREG collection points would begin to evacuate remains to the next higher echelon without processing when backlogs become unacceptable. This excursion was designed to evaluate the effects of evacuation of unprocessed remains on the system. Evacuation decisions were based on a collection points backlog. When the backlog of a given collection point reach a 2 day level, based on mean processing times, all succeeding remains were automatically sent to the queues of the next collection point.

Evacuation of unprocessed remains reduced the backlogs of forward and rear collection points to a manageable level and reduced the delay time of remains reaching the cemetery by more than 50%. The average reduction in total backlog (when compared with the base case) for brigade/ACR collection points in this excursion was 75%, the highest of all excursions tested. This was a result of the dramatic decrease in backlog at the ACR. This was the only excursion that resulted in reducing the backlog of the ACR to a manageable level. The division and corps intermediate collection points completed processing of all remains by the end of the excursion. The increase in backlog at the cemetery that would result from such an evacuation policy was not evaluated.

5.8 DECENTRALIZED EXCURSION

A decentralized excursion was conducted to evaluate the performance of division cemeteries. Base case workloads were used, but the base case organization was changed to allow for division cemeteries. Total GRREG strength in the Corps remained the same but personnel assets were reorganized to provide for a cemetery in each division rear as well as the COMMZ.

Backlog in the brigade/ACR collection points was again substantially reduced by this excursion. The average reduction in total backlog (when compared with the base case) for brigade/ACR collection points was 47%. Only the ACR and the division cemetery had unprocessed remains at the end of this excursion. Given the large backlog of unprocessed remains in the division rear, it is unlikely that this organization would be an acceptable alternative.

5.9 CONTAMINATED REMAINS

An excursion was conducted to evaluate the processing of chemically contaminated remains at a collection point. A new task list for contaminated remains was developed. Task times were increased to reflect work/rest cycles and performance degradation resulting from wearing heavy protective clothing. One Brigade collection point was simulated with its base case workload and the contaminated remains task list.

Contaminated remains processing increased backlog and reduced throughput in the collection point by more than 60% when compared with the base case. Worker productivity fell to less than 0.5 remains per day for this excursion. Processing contaminated remains has a severe negative effect on performance.

5.10 SUMMARY OF CAPABILITIES

The excursion that was most effective at reducing average backlog at brigade/ACR collection points was the evacuation to higher echelon excursion. The disadvantage of this excursion, however, is that it substantially increases cemetery backlog and the number of remains received by the cemetery without initial processing. In operation, these may be serious disadvantages. The effect these disadvantages on cemetery performance and rates of identification may be severe.

The results of the decentralized excursion show that division cemetery operations are not feasible unless the number of GRREG soldiers available for division cemeteries is increased. With the limited assets available, a centralized cemetery operation is more efficient.

Elimination of ID processing was slightly more effective in reducing backlog at brigade/ACR collection points than doubling the workforce of these collection points. Both excursions reduced average backlog by more than 50%. It is unlikely, however, that brigade/ACR collection point strength could be doubled in our current force structure. A more realistic alternative would be to reduce ID processing times through the development of a highly accurate, automated, sole-source ID method and, at the same time, increase brigade/ACR collection point strength as much as possible without removing assets from the cemetery. In emergency situations, where brigade/ACR collection points must move quickly or if an unexpected surge in workload occurs, evacuation of unprocessed remains to the next higher echelon should be implemented.

Results of the base case simulation support the pending reorganization of the GRREG force structure in the corps rear area. Initial and intermediate collection points in the corps rear area are redundant and underutilized. These assets could be better utilized at brigade/ACR collection points or cemeteries in the Corps and COMMZ.

The authorization of personnel in GRREG augmentations in the ACRs is seriously inadequate. Projected workloads for ACRs far exceed the capability of their GRREG augmentations. The situation in ACRs is much worse than in the Brigades of Heavy Divisions.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The current GRREG force structure is inadequate for the future battlefield. There are shortfalls in doctrine, procedures, unit organization, equipment, and training. Procedures and equipment have not kept pace with technology.

- Current procedures result in a severe bottleneck of unprocessed remains at the brigade and division collection points. The backlog of unprocessed remains at these collection points will be unacceptably large, under current procedures and unit organization, during intense hostilities.
- Current procedures and unit organization result in underutilization of GRREG collection point assets in the Corps and COMMZ and overutilization of GRREG collection point assets in the Division.
- Zero ID processing reduced average backlog by 60%.
- Doubling the workforce reduced average backlog by 50%.
- Decentralized organizations were not successful. Collecting point backlog was reduced by 50%, but cemetery backlog was unacceptable.
- Current procedures are not automated in any way. GRREG units lack data processing equipment that would automate the acquisition of data, preparation of forms and reports, and transfer of information.
- Current identification techniques are much too slow. Long ID processing times contribute to unacceptable backlogs of unprocessed remains at collection points and the cemetery.
- GRREG units lack equipment to automate identification of remains and reduce identification processing time.

6.2 RECOMMENDATIONS

The following is a partial list of recommendations made to the Quartermaster School as a result of the BRL study.

- All procedures involving the preparation of GRREG documentation, data acquisition and transfer, and management control functions should be automated with data processing equipment.
- GRREG units should be able to interface with the Division personnel system to receive automatic personnel data to assist in planning GRREG operations and performing identification.
- Identification procedures at initial collection points should be shortened through the use of automated identification systems, or eliminated.
- Fingerprints should be included on any future soldier data card. The Army should database fingerprints and dental records of all active duty soldiers and provide GRREG units with on-line access to this database.
- Intermediate processing of remains should be eliminated. A GRREG Company, operating a temporary cemetery, should be located in the Corps area.
- Disposition of remains under a Graves Registration Program should be carried out at a centralized temporary cemetery. Decentralized GRREG organization for disposition should not be attempted.
- The personnel authorizations of GRREG augmentations in ACR should be increased.

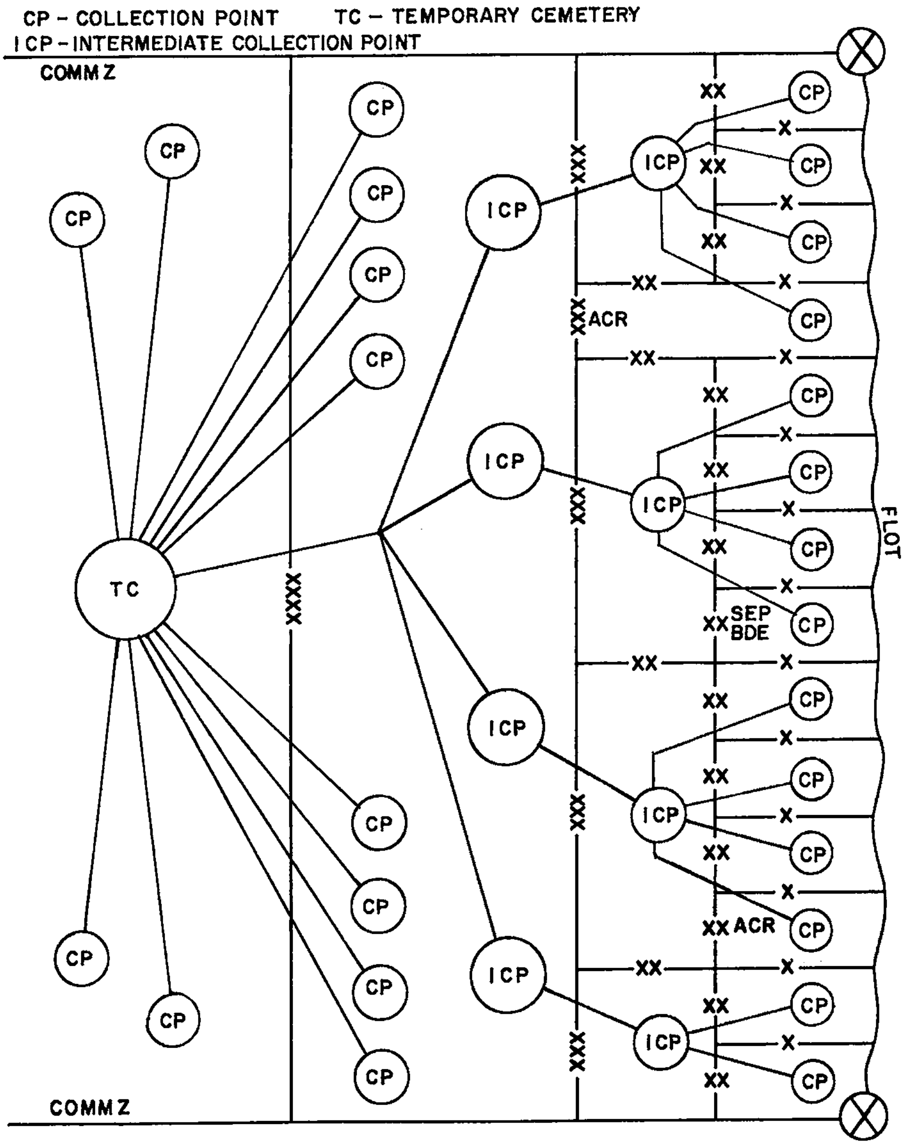

Figure 1. Top Level Network

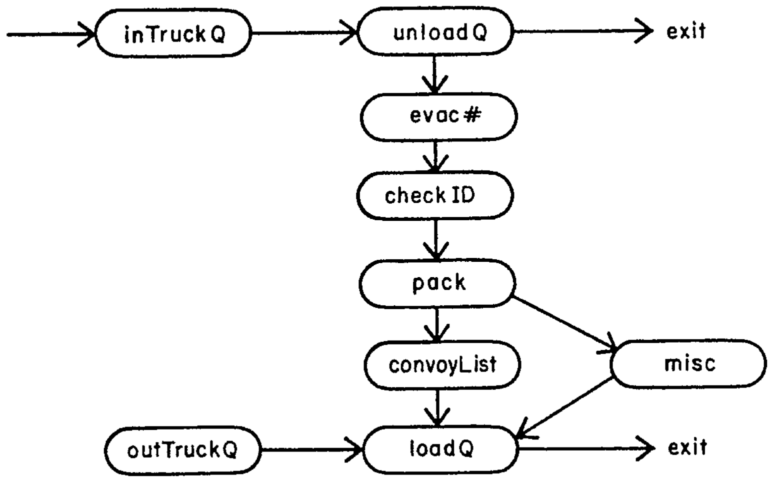

Figure 2. Initial Collecting Point Task Network

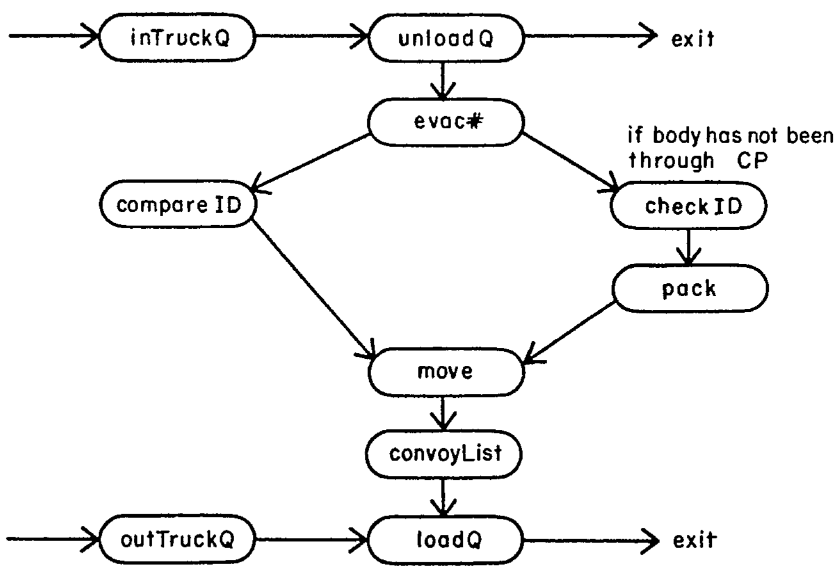

Figure 3. Intermediate Collecting Point Task Network

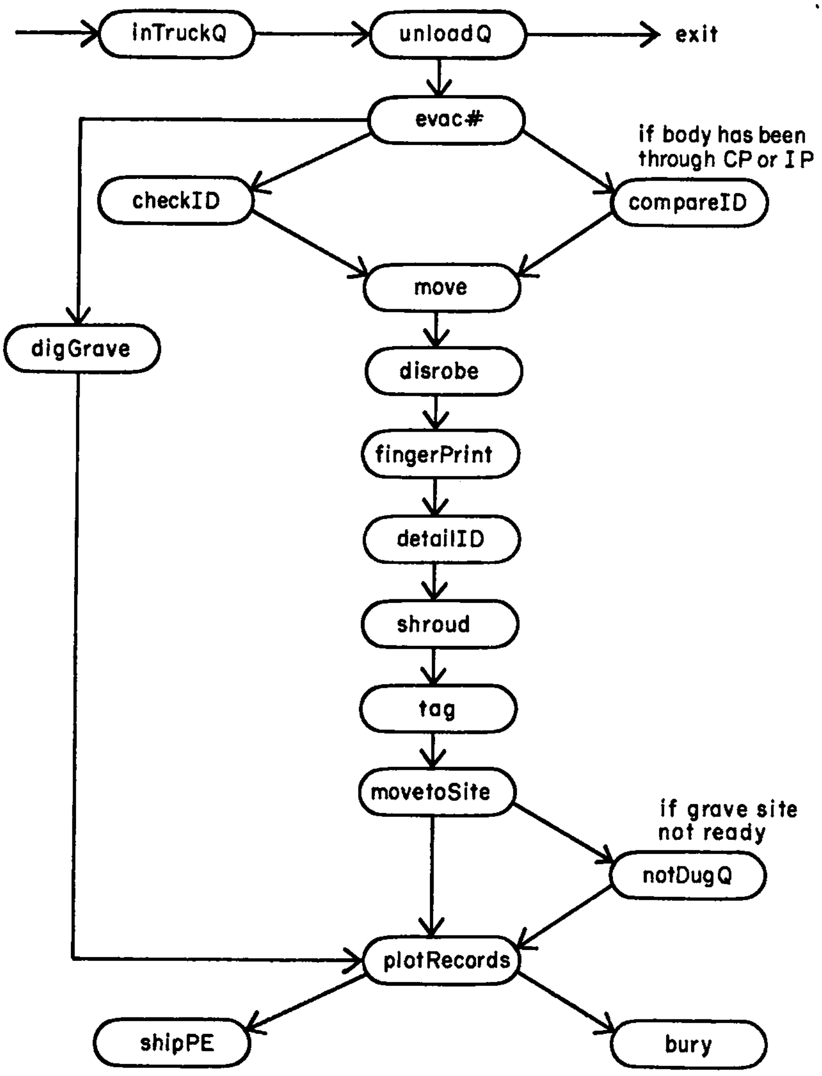

Figure 4. Temporary Cemetery Task Network

NOTES

Smalltalk-80 is a trademark of the Xerox Corporation.

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