Tactical Logistics Distribution System

ABSTRACT

New doctrine, procedures, techniques, equipment, and systems impose challenges to expeditionary logistics. The Tactical Logistics Distribution System (TLoaDS, pronounced 't-loads') modeling tool qualitatively assesses the performance of tactical distribution systems in sustaining the forces ashore from a sea base or other forward base. TLoaDS consists of logistic algorithms in a discrete event simulation that allows deterministic and stochastic solutions. Time varying boundary conditions and unsteady responses are observable. TLoaDS permits the analyst to simulate a wide variety of missions and ways of sustaining them.

Consumption depends upon mission, threat, force composition, attrition, geography, weather, and scheme of maneuver. Supply depends upon echelonment, stock control, pull/push method, and prioritization rules. Transportation depends upon loading rules, MHE, transporters, convoy rules, distribution network, sea/surf/road conditions and unloading rules. In addition, all processes are subject to delays and losses which endeavor to simulate the fog of war.

TLoaDS already characterizes dozens of present and future types of equipment and CSS facility types. If TLoaDS doesn't already include a desired unit, commodity, container, transporter, MHE, convoy rule, terrain type or delay, wizards guide the user through entering all the information for a new one into the internal database. Or the user can modify the characteristics of existing entities and processes. A windows based graphical user interface facilitates laying down the force, building the distribution network and scripting the scheme of maneuver. The run speed of the model has been increased by over one hundred times of comparable models by the novel use of 'fast array' processing. Other features include built in error checking routines and on-line help.

TLoaDS computes, tracks and plots all consumption, stock levels, process decisions and step durations, transporter use, maintenance and fuel consumption. Map based animation dynamically displays unit positions, stock level status, supply relationships and convoy movement. Built in plotters, queries, reports and an external workbook automatically reduce vast amounts of data into useful time plots and bar charts. The workbook also computes summary measures of distribution system performance such as continuity, responsiveness, utilization, efficiency and survivability to support course of action analysis.

TLoaDS has many applications. Exploring emerging concepts such as Sea Based Logistics, adjudicating war games, stimulating combat models or logistics C2 systems, educating logistics students, assessing under what conditions different techniques such as intelligent pull are appropriate, evaluating alternative concepts for future equipment such as unmanned delivery vehicles, determining the sustainability of an impending operation, and advising on the allocation of distribution resources during an operation to avoid choke points, are just some of the potential uses of TLoaDS.

Note to pdf file Viewers.

On our screen, Figures 1, 4, 5 and 6 are poorly rendered when reduce in size. Expanding your view enough (how much depends upon your screen resolution setting). But when we print, they come out sharp.

Figures 2, 3, 10, 12 and 13 look good, but a little fuzzy on screen. When printed they are still fuzzy. This is due to the anti-aliasing done when the graphic was created. Clearer views of these and other screens can be seen at tloads.nfesc.navy.mil/features/screens.pps.

INTRODUCTION

OMFTS, Forward from the Sea, STOM, and Sea Basing present innovative challenges to tactical logistics. New doctrine, procedures, techniques, organizations, equipment, and systems require solutions to achieve precision, expeditionary logistics.

The Marine Corps Systems Command AWT Directorate and the NFESC developed an in-house modeling and simulation tool called TLoaDS (Figure 1). TLoaDS quantitatively assesses current and future logistic distribution system design and performance to sustain forces ashore from forward bases including sea bases.

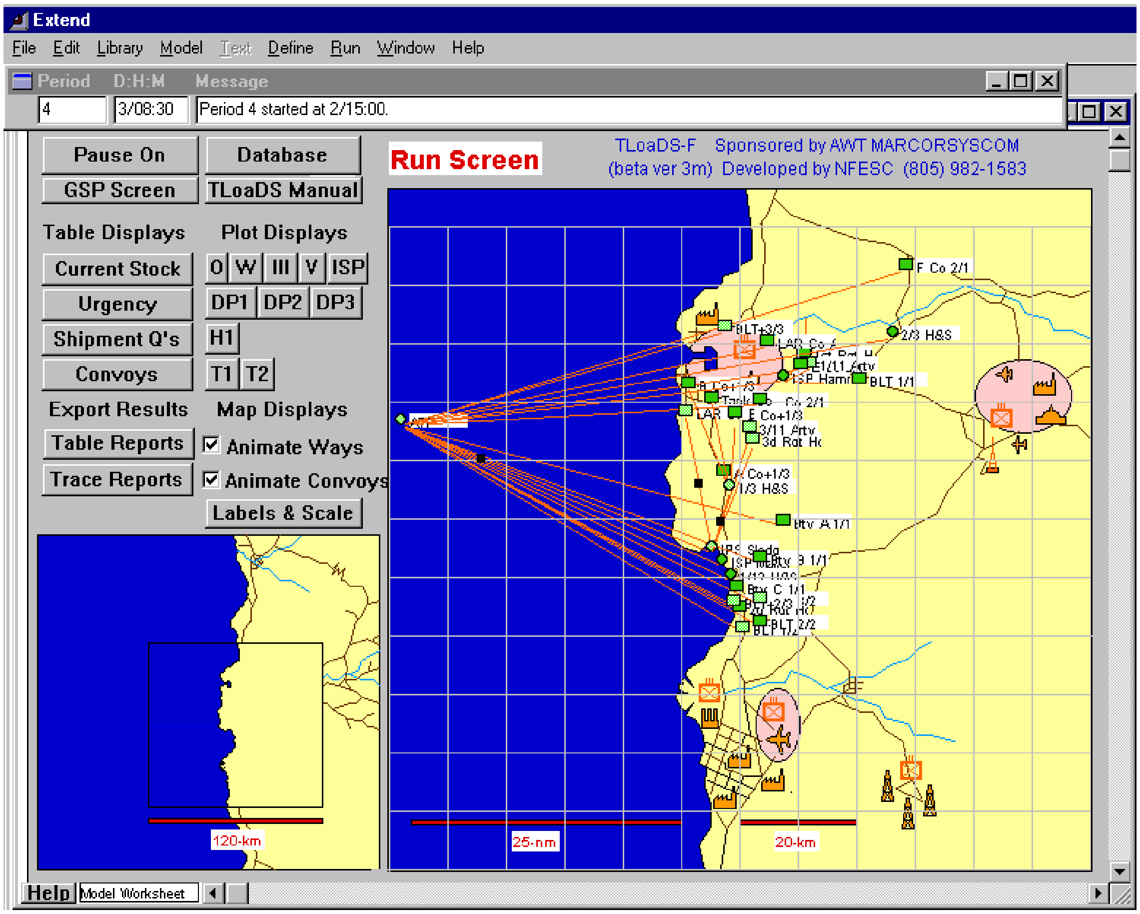


FIGURE 1. TLoaDS Run Screen.

TLoaDS, a moderate fidelity tool, simulates a wide variety of missions, task organizations, distribution trees, tactics, techniques and procedures. TLoaDS also simulates a growing number of current, future and conceptual aircraft, ships, lighterage, material handling equipment and vehicles. TLoaDS simulates the consumption of supplies. Orders are submitted, processed and prioritized. Shipments are created and loaded on transporters by MHE. When appropriate conditions are met, the transporters or convoys are dispatched to ground units. Once there, supplies are off-loaded. All through the process, delays and attrition randomly occur.

New ships, lighterage, aircraft, vehicle, and material handling concepts can be evaluated. The impacts of different sea-base standoffs, littoral penetrations, weather conditions, aircraft flight patterns, stockage objectives, safety levels, convoy techniques, equipment types or modifications, equipment availabilities, fuel efficiencies, and process rates can be assessed.

TLoaDS was sponsored by the Marine Corps Systems Command (MARCORSYSCOM) Amphibious Warfare Technology (AWT) Directorate and developed by the Naval Facilities Engineering Service Center (NFESC).

BACKGROUND

TLoaDS grew out of the merger of an NFESC database model to evaluate future fuel distribution concepts and an NSWC-CD discrete event model to evaluate future aerial delivery concepts. Their usefulness led to developing a general model of the entire tactical distribution system called TLoaDS-Discrete. As the larger concepts and requirements community expressed interest, the need to make a faster, user-friendly application led to TLoaDS-Fast, now simply referred to as TLoaDS. This document describes TLoaDS features and use, and illustrates how it helps the concept developer, engineer, and logistician in resolving the issues encountered in today’s and tomorrow’s scenarios.

SCENARIO SCOPE

TLoaDS can simulate almost any scenario a user has in mind:

- Mission – Major theater war, peacekeeping, and humanitarian assistance to NEO or raid, whether by OMFTS or SOA.
- Threat – High tech combat systems: weapons of mass destruction, low tech non-state guerillas, civilian rioters, or natural disasters.
- Troop - A multi-MEF MAGTF to a small, special-purpose MAGTF, with joint or allied
- Terrain - Desert, jungle, arctic, and urban, with any climate or weather.

Complex interaction of scenario conditions is simulated by setting up the model’s higher resolution elements. In time, as users develop scenarios and the library of available scenarios grows, users will locate a scenario close to the one they have in mind.

MODEL ELEMENTS

TLoaDS actually simulates linear and nonlinear logistic system entities and processes in the time domain and computes stochastic and deterministic results. TLoaDS is a discrete event model that simulates the interaction of:

- Conditions – Force laydown, combat tempos, scheme of maneuver, enemy threat level, MOPP, austerity, terrain, climate, weather, darkness.
- Entities - Operational units, CSS facilities, CSSOC order desks, orders, storage spaces, shipments, loads, MHE, loading spots, transport pools, vehicles, aircraft, routes.
- Processes and their delays and discrete events - Consuming supplies, taking inventory, placing orders, unitizing materials for shipment, loading shipments on transporters, routing and dispatching transporters, transiting and unloading shipments, restocking, refueling transporters, maintaining transporters.
- Problems - Equipment breakdowns, accidents, detours, storms, communication blackouts and failures, mission pauses, lost orders, snafus, enemy attacks, obstacles, and mine detonations.

SOFTWARE AND HARDWARE

TLoaDS employs a commercial-of-the-shelf, object-oriented modeling application. The simulation speed of this software is increased by orders-of-magnitude using fast array processing. The flexibility and ease of use is radically increased with a custom graphical user interface. The simulation engine is one of the most advanced, and is by far the most popular in the Windows and Macintosh community. The engine integrates both discrete event and continuous modeling, brings out the best of each method, and provides exactness with event markers and replication of system response growths and decays. The whole application environment is very open, which is unusual for high powered modeling applications.

The software runs on a Windows 95 or NT personal computer with minimum specifications of a 75-MHz Pentium processor, 32 megs RAM, 50-MB of hard drive space, and 1024 x 768 video resolution. Most users only need the $100 SDI Industries/Extend runtime application to set up and run TLoaDS, or enhance the *simulation*. Advanced users who want to take advantage of the open architecture, object library blocks, and easy to read Mod-L code to enhance the TLoaDS *application* themselves require the $900 Extend application.

MODEL ENTITIES

Entities are tangible things the model distinctly represents. Each occurrence of an entity can have its own properties and individually interacts with other entities during the discretely simulated process steps.

Commodities

Each node may require different types and amounts of supplies, depending upon the operation. The notional info part of the database includes multiple consumption rate planning factors. The scripting part of the database contains the user's selected factors for each node and period. At present there are twenty-one commodities covering six classes of supply. The interval by interval consumption of different commodities is calculated different ways:

- Class I – the ration type for breakfast, lunch and dinner are scripted for each node, and the gallons per man per day water factor varies by global scripted weather, and node scripted cooking, hygiene, medical and MOPP allotments,
- Class III – for two types of fuel, gallons per unit for a node scripted tempo is summed up for all units in the node,
- Class IV –pounds per man per day of construction supplies is a static global consumption factor, but the allotments for nodes not identified as a construction unit are consumed at the nearest upstream supplier than is so identified,
- Class V – for eleven types of ammo, pounds per unit for a node scripted tempo is summed up for all units in the node,
- Class VIII – pounds per man per day of medical/dental supplies is a static global consumption factor, but the allotments for nodes not identified as a medical unit are consumed at the nearest upstream supplier than is so identified,
- Class IX -– pounds per man per day of maintenance/repair supplies is a static global consumption factor, but the allotments for nodes not identified as a maintenance unit are consumed at the nearest upstream supplier than is so identified.

In addition, percent troop strength is scripted for each node, and this factor is applied to all the above commodities to reflect unit attrition. Also each node can get any percent of its rations, water, fuel, construction or medical supplies from an external source. And remember the commodity wizard can be used to add a new commodity if the user cares to address another commodity type or class of supply.

Nodes

There are two types of nodes in TLoaDS.

- User nodes just receive, stock and consume supplies, and place orders when a commodity runs low. User nodes typically represent a maneuver element RRP, FARP or small individual unit. User nodes are shown on the laydown and run windows as rectangles.
- Supplier nodes, in addition to the above processes, also receive and prioritize orders; pull stocks and package loads; manage shipping, transport and MHE queues; load the loads onto transporters; route, convoy and dispatch transports, and when transporters return, refill and maintain them. Supplier nodes typically represent a sea base, POD, BSA, FCSSA, CSSA, EAF, LZSA, CSSD or MCSSD. Supplier nodes are shown as circles.

As the simulation runs, nodes change location and properties each period according to the scripted scenario. Only satisfactory run speed and willingness to script all the nodes' behavior limits the number of nodes.

In addition, there are tables defining Standard Nodes. These tables contain default values that are loaded into the simulation when the user creates new nodes. This saves the user many hours of tediously entering repetitive inputs.

Containers

Numerous types of containers and load bases exist to transport supplies: pallets, ISO containers, sixcons, bladders, drums, nets and others the user can create with a container wizard. The capacity of each container type for each commodity type, capacity of each transporter type for each container type, and how long it takes to load each allowable combination of container, handler and transporter, is specified.

Handlers

Numerous classes and types of handlers exist, and there is a wizard to add more.

Examples of the types already in the model for each class of handlers, and some of the conditions that affect their performance are:

- Material handling equipment – At supplier nodes loading and unloading times for MHE such as 4K forklifts, EBFL, TRAM, RTCH and Mobilizer, are user set by containex-handler-transporter combination. At user nodes, unloading time equals distance carried divided by MHE speed, which varies by smooth or rough, and loaded or unloaded conditions. Preventative and corrective maintenance is addressed by daily and weekly PM hours, MTBF and MTTR inputs.
- Cargo handling equipment – At sea base or other ship-like supplier nodes, the throughput of inter-ship CHE such as UNREP highlines, pedestal or boom cranes, VERTREP helos or SURFREP LCACs, are affected by lbs/load, percent tare, cycle time, and number of spots. The throughput of UNREP hoselines is affected by their flowrate. These factors can vary for each material type.
- Transporter integrated handlers – The material transfer rate of TIH such as LVS MK17 and MK18 is currently simulated by the judicious use of the parameters available for MHE.
- Pumps – The flow rate of pumps like the 600-gpm DDMF pump, 350-TAFDS pump and 125-gpm ERS/sixcon pump is currently simulated by the judicious use of the parameters available for MHE.
- Troops – The material transfer rate for troops is currently simulated by the judicious use of the parameters available for MHE.

Transporters

Numerous classes and types of transporters exist, and there is a wizard to add more. Examples of the types already in the model for each class of transporters, and some of the conditions that affect their performance are:

- Ground – The speed of the LVS 48-14, LVS 48-17, 5T w/ water bull, 5T with fuel sixcon, HMMWV, and LAV-L, are affected by terrain, bad weather, night, and availability of night vision aids. The payload is affected by terrain.
- Helo – The payload of the CH53E, MV22, CH46, UH-1N is affected by distance between nodes, speed, weather cushion, fuel reserves, temperature and altitude of takeoff and landing sites, and if can refuel at customer. Speed is affected by internal or external lift.
- Seacraft – The speed and payload of the LCAC, LCU and AAAV are affected by sea state, and for LCAC payload, the temperature. There are sea state and beach surf index operational limits.

Additional realism is simulated for all transporters by:

- Both weight and cube limit the payload,
- Meander factors adjust the straight line distance to reflect the curves and turns of each route,
- Maintenance, repair, recovery, threat, and bad weather probabilities and delay times slow deliveries and take transporters out of service. A delay wizard defines additional causes of delay,
- Transporter attrition reduces the number of transporters over time,
- The fuel consumption of transporters is computed while they are operating, and when they are refueled, the corresponding node's fuel stocks are depleted.

Convoys

Convoys are groups of vehicles transporting materials between nodes. Convoy specifications include the minimum total number of vehicles, minimum quantities for each vehicle type, and the maximum time that the convoy waits for these requirements to be met. Convoys can also wait a set amount of time for loading additional shipments destined for the same user.

MODEL PERIODS, PROCESSES AND DELAYS

TLoaDS simulates in the time domain. Heart of a discrete event model is its simulation engine. The engine has a system clock and a scheduler that keeps track of all the events, their fixed durations, or the other events and conditions that start and stop them. The key time based model elements are periods and. processes

Periods

Periods allow the scenario to change with time. Dozens of "run time" parameters can be individualized for each node for each period. A few global parameters can also change with each period. Together, they script the simulation to reflect the progression of the scenario.

Processes

In this paper we can only begin to discuss the options TLoaDS provides the user over controlling the ordering, prioritizing, packaging, loading, and dispatching processes.

- Ordering – Stock objective and safety level can be set for each node to reflect the degree of just-in-time or just-in-case; the replenishment system can be set to either pull, intelligent push, or pure push; the source of each commodity can be sent individually to simulate direct or general support.
- Prioritizing – User controllable factors in prioritizing orders include the urgency of the commodity, the priority of the customer and the priority of the commodity

- Packaging and Loading – These processes are very intertwined. How loads are created is affected by how they will be transported. One way the user affects how transporters are loaded is by choosing between the “Use first OK vehicle/MHE combo” and the “Use scoring system” options. If the later, then the user weights the scoring system’s three goals: 1) complete partially filled shipments, 2) use shortest transporter queue, and 3) use preferred transporter for this commodity.
- Dispatching -- There are adjustable parameters to determine when a transporter is full, and how long to hold a partial shipment waiting for more loads to fill it. Once full, transporters can proceed when the route is open and the customer can receive it. Or the transporter can be held for an adjustable period of time waiting to be formed into convoys according to user defined convoy rules.

MODEL WINDOWS

The graphical user interface uses standard Windows 95/NT conventions such as: drop down menus, floating buttons pallets, dialog boxes, scroll bars, tabs, drag to adjust column and row sizes, combo boxes, right mouse click context sensitive command menus, and wizards.

Opening Screen and Button Pallet

TLoaDS opening screen (Figure 2) shows navigation buttons with brief functional descriptions of each. Clicking on any button opens the appropriate window and a floating pallet of the same buttons (in the upper left of Figure 2) surface. When the user is done with the selected window, clicking on another navigation button closes the previous active window and opens the newly selected one.

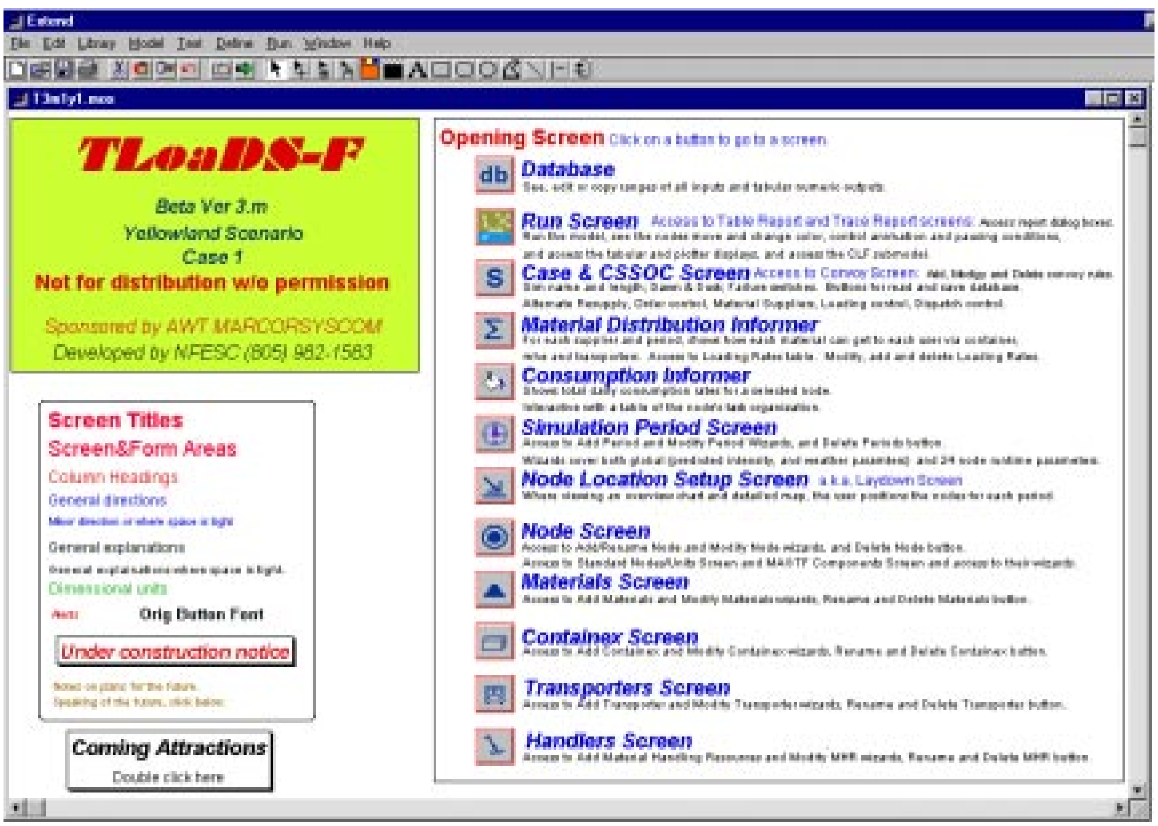


FIGURE 2. Opening Screen.

Database

The Database button on the Run Screen (Figure 1) opens the internal database (Figure 3). All input, intermediate, and output information from the core Extend model resides here. At present there are over 120 tables of parameters in the database. Tabs, hypertext table names, and scroll bars provide quick access to any data. Each cell of any indexed field is actually a combo box that the user can double click to select a new option. The user may drag to select a range of cells to paste into any Windows application.

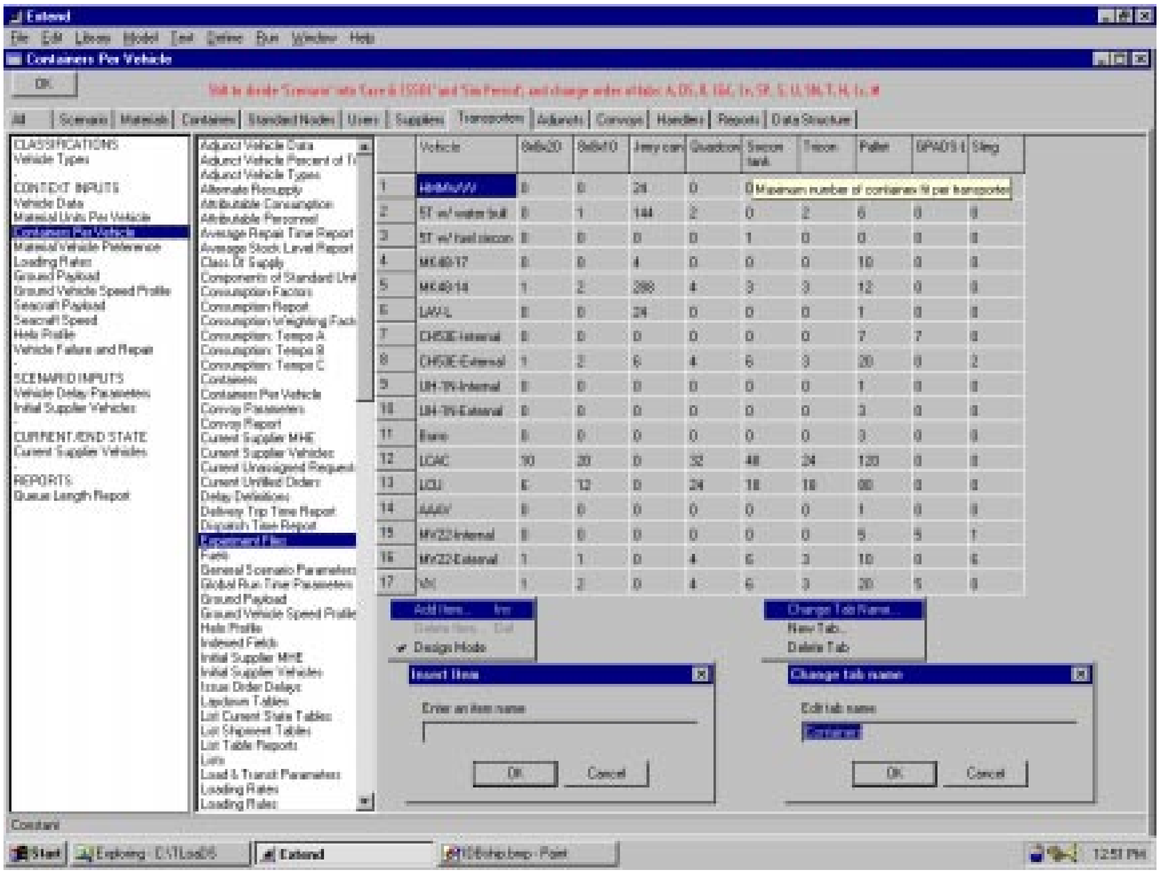


FIGURE 3. Internal database w/ design windows open.

Laydown Screen

The Laydown button on the run screen (Figure 1) opens the laydown screen to permit the laydown of forces and assets. The screen looks very much like the run screen, but the button pallet has different choices that allow the user to reposition the nodes (e.g., forces, facilities) for each user-defined time period of the model. Unit positions are shown in a modified UTM 6 digit format. With the release of Extend 4.1, TLoaDS now supports a “click-n-click” node reposition feature. Instead of the conventional drag and drop, the user first clicks once to enter this control mode, and clicks again where he wants the node to be. The buttons to move a node a fix distance up, down, left, or right, remain. There is also a dialog box to set the label options. The labels can be the node serial numbers, their names, or hidden. The length of the label is also adjustable.

Wizards

Other buttons open the setup wizards. Wizards modify existing, or create new nodes and periods, and types of commodities, containers, MHE, transporters, convoys, and delays. Each wizard takes the user through entry forms of a related set of inputs. Some of the wizards address node composition, consumption rates, ordering and supply process, container characteristics, transporter characteristics, transport processes, and static global parameters (Figure 4).

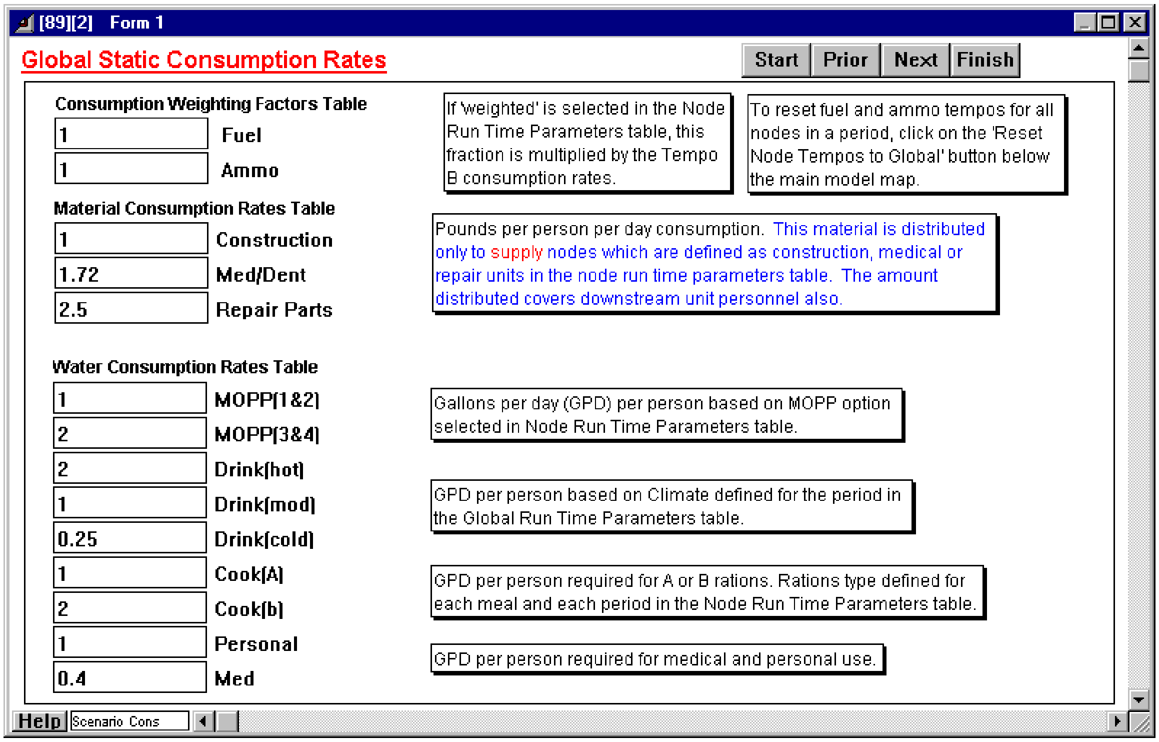


FIGURE 4. First form of the Case and CSSOC screen wizard.

Informers

There are two special windows (not shown) for setting up the most complicated system relationships.

- The Material Distribution informer shows and edits the relationships between commodities, containers, MHE, transporters, and nodes for each time period. It shows all the ways, with respect to distribution equipment, that a commodity reaches a customer from a supplier in a selected period.
- The Consumption informer assists the laydown process by showing how the available MAGTF units are task organized into the various nodes. It also displays the aggregate consumption rates for a selected tempo for the task-organized nodes.

Run Screen

The Model button opens the run screen (Figure 1). The run screen has a small-scale map of the operation area and a large-scale map of the objective area. The simplified maps illustrate only the major physical features for clarity; NIMA maps or intelligence imagery may be used instead. When the simulation runs, the run screen animation shows the changing node locations, and movement of convoys. In addition, the nodes change color to indicate the urgency level of the commodity most urgently needed. The animation can be turned of totally or by parts to increase the simulation run speed. A block of buttons provides easy access to the other TLoaDS screens and windows most often accessed during the running of the model. These include the internal database, the on-line manual that is distinct from the help system, the table displays and plotters. The Pause On button selects criteria for when the simulation should automatically paused.

- At the start of each period
- When a supplier runs out of material
- When either a suppler or a user node runs out of material
- When a transporter is attrited

The Labels & Scale button is used to register and scale the maps, and control the node label appearance.

Table Displays

The top four buttons shown under "Table Displays" on the run screen (Figure 1) open run-time status tables. As the model runs, the information in each display continually updates. The Current Stock button opens the Dump Status/Commodity Status window (Figure 5a). The option buttons at the bottom of the window determine which Status View is active. The button at the top determines what nodes dump or what commodity is queried. The shipment Q's button opens the Shipment Queue display (Figure 5b).

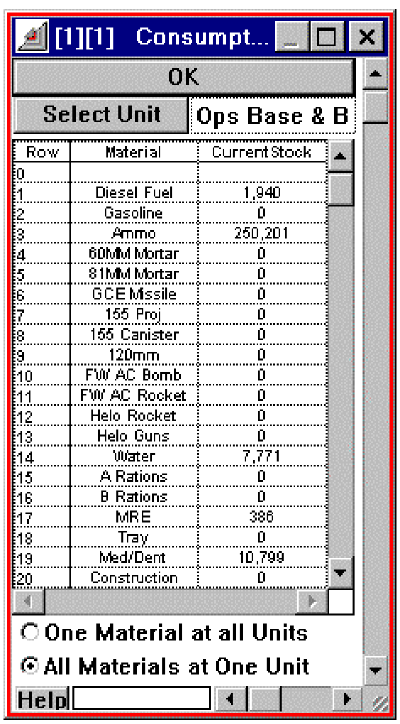
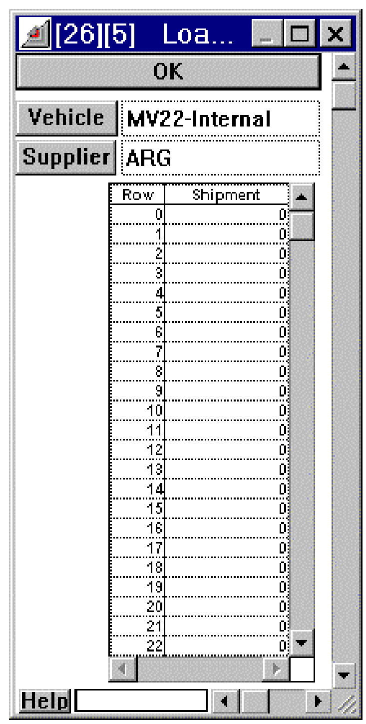


FIGURE 5a
Dump Stat
Display

FIGURE 5b
Shipment Queue
Display



Plotters

The top six buttons under "Plot Displays" on the run screen (Figure 1) open the plotters. Each plotter can be setup to display four different plots, each plot showing up to four traces. Any variable in the internal database can be plotted against time (in minutes). As the model runs, the plots continually update. Built-in tools automatically or manually control the plot scales, grid, and trace attributes. Some plots from some of the plotters we have already set up are explained below.

- Transporter plots -- Figure 6 shows two plots indicating the number of selected types of transporter in the respective transporter pool. The upper limit of the line reflects the total number of transporters assigned to that node. Dips in the line reflect transporters that have been dispatched but have not yet returned and received any necessary preventative or corrective maintenance, and refueling before returning to their transport pool.

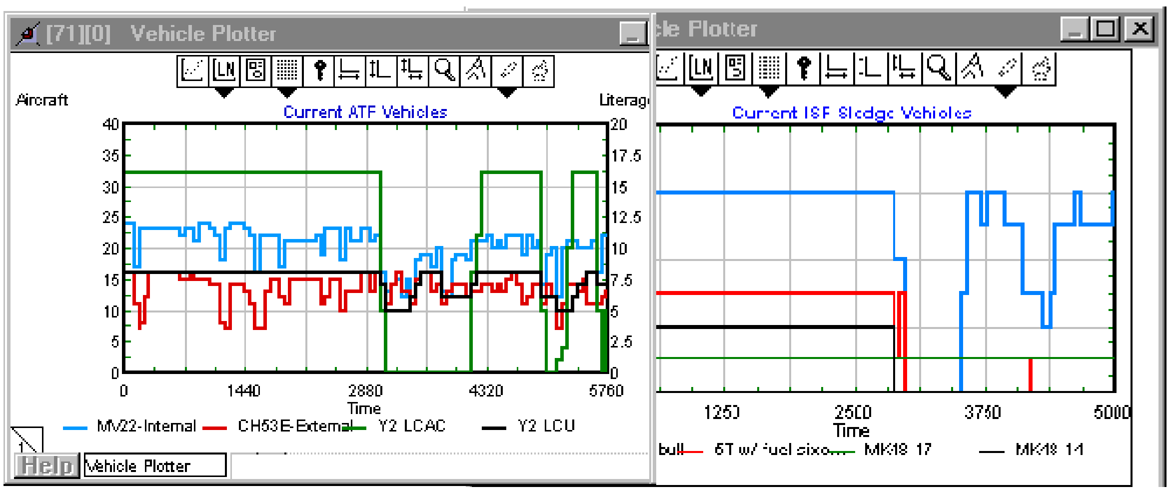


FIGURE 6. ATF sea base transporter plot and ISP Sledge vehicle plot.

- Stock level plots -- Figure 7 shows the stock level of a four selected commodities at one of the other intermediate support points (ISP). In this scenario the ISP was envisioned to be a regimental train. The slow drop in stocks refects the materials consumed at the ISP while the sudden drops represent major shipments to down stream nodes.

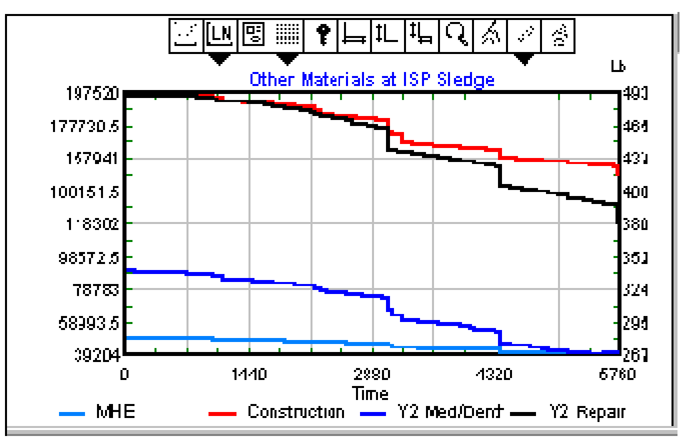


FIGURE 7. Stock level plot at ISP Sledge

- Stock control plots -- Figure 8 depicts the stock control parameters of a selected commodity (fuel or ammo) at a selected node (IPS Hammer or the H&S Company for 1st Bn 3rd Marines). Note the steady slope of the fuel current stock plot. This reflects the constant ‘assault’ consumption rate. A change to a shallower steady slope would reflect a change to a constant ‘build-up’ or ‘sustained’ consumption rate. But note the slight irregularities in the ammo stock plot. This reflects uneven consumption, more realistic. This was achieved by making this nodes ‘assault’ consumption rate a stochastic input variable and selecting an appropriate random distribution. Note the ammo plots jump up about a third of the way across the time axis. This is because this node was not landed until H+32. Note how the reorder point is recomputed after an order is received. We programmed the reorder point to be a weighted average of the previous three order-ship times. This is a good example of TLoaDS ‘intelligence’ that could be superior to what is typically done in the field today, but foreshadows an improvement that should be implemented by future CSS command and control systems. Looking at the fuel’s on-order and current request plots, we see the ISP Hammer’s fuel orders are being processed in a very timely manner, but Bn 1/3’s is suffering very poor responsiveness to its ammo orders. It comes as no surprise then that this node has run out of ammo.

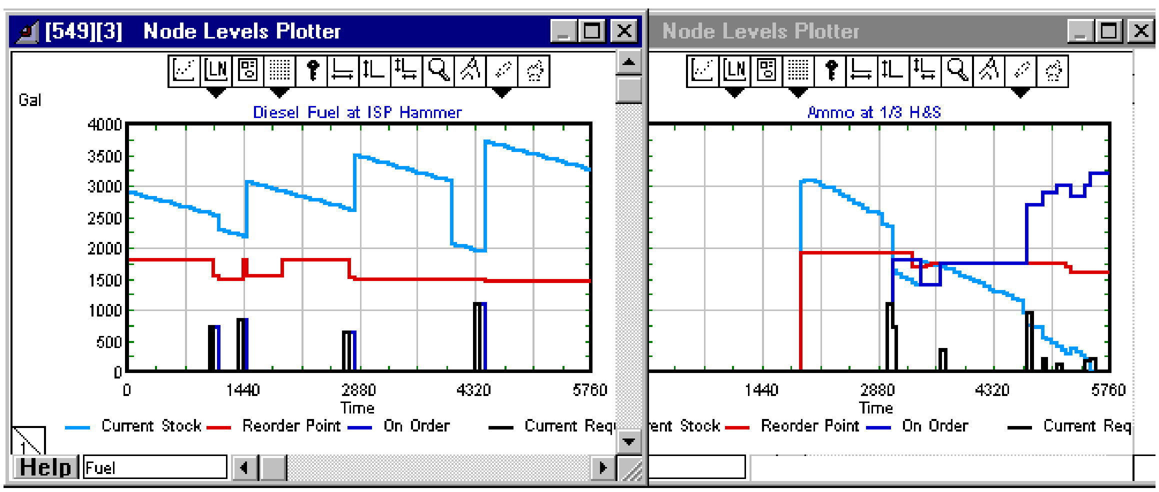


FIGURE 8. Stock control plots for ISP Hammer fuel, and 1/3 H&S ammo.

Trace Reports

The Trace Reports button (Figure 1) opens a window that controls the creation of trace files (Figure 9). Trace files are narrative records of all process decisions TLoaDS makes according to the user’s process control inputs. The four trace files are: consumption, loading calculations, order processing, and trip calculations.

If the user selects to record all the information that can be generated by these four files for a small 6-node, 4-period, 8-day, 20-commodity, 12-container, 10-MHE, 20-transporter case the number of lines would exceed 100,000. A sample of lines from two of the trace files is shown in Figure 9. Note the timed events and the record of decisions. The files illustrate the realistic nature of discrete-event simulation and allow the user to identify the precise reasons for a specific event. The suppliers, vehicles, shipments, and materials are identified by their index number, and thus, could help future digitized CSS operations center.

#940 MRE stock + on order = 1297.0625. Consumption until resupply 735.3142 Request 15.751703; urgency is 6.
#941 Med/Dent stock + on order = 23370.75. Consumption until resupply 13247.115 Request 280.3651; urgency is 5.
#942 Construction stock + on order = 0. Consumption until resupply 0 Request 0; urgency is 6.
4:00:00 PM 8160#943 Do request at Ops Base & BSA. Material Med/Dent is triggering the order.
In stock + on order = 23217.615; order point is 24207.363.
#944 Diesel Fuel stock + on order = 15805.443. Consumption until resupply 10989.934 Request 2137.8554; urgency is 2.
#945 Ammo stock + on order = 643712.49. Consumption until resupply 447578.06 Request 87049.57; urgency is 6.
4:08:00 PM 968 Shipment 3 is loaded. remove vehicle 1 from Q at supplier 2
4K Forklift maintenance is 0.5 at Ops Base & BSA
4:16:00 PM 976 Shipment 1 is loaded. remove vehicle 3 from Q at supplier 2
Pump maintenance is 0.5 at Ops Base & BSA
4:38:00 PM 998 Return 4K Forklift to motor pool at Ops Base & BSA
Lookup first shipment at supplier 2. Vehicle: 1 S: 4
4K Forklift just became available and SELECTED to load 1 Pallet from shipment 4 onto a HMMWV. Time to load 1.
Lookup first shipment at supplier 2. Vehicle: 5 S: 6
4:39:00 PM 999 Shipment 4 is loaded. remove vehicle 1 from Q at supplier 2
Troop SELECTED to load 24 Jerry cans from shipment 5 onto a HMMWVV. time to load 6.
Pump just became available and SELECTED to load 1 Sixcon tank from shipment 6 onto a MK48-14. Time to load 10.
4:41:00 PM 1001 Assign material 1 to a vehicle shipment going to node 4. Order units: 47.095458
Selecting Load Combo for supplier 2, node 4, and material 1. First OK load is 399.
Loading Rates table row 32.
Score for Loading Rates row 32 is 0. Rule is shortest vehicle queue length
Loading Rates table row 33.
At supplier 2, last shipment for vehicle 3 is 0. Node 0
1 container spaces available for container Sixcon tank. Remaining payload: 20000. Units to load 47.095458 of material 1
Shipment 7; vehicle 3; Material 1 containers to load: 1; units to load: 900.
Assign material 3 to a vehicle shipment going to node 4. Order units: 3577.7623
Selecting Load Combo for supplier 2, node 4, and material 3. First OK load is 249.

FIGURE 9. Trace file sample.

Table Reports

The Table Reports button (Figure 1) opens a window (Figure 10) where new reports can be created or modified. Reports are queries to the internal database. Another button exports all results to a spreadsheet file (e. g., Excel). The user can further analyze or plot the output as needed.

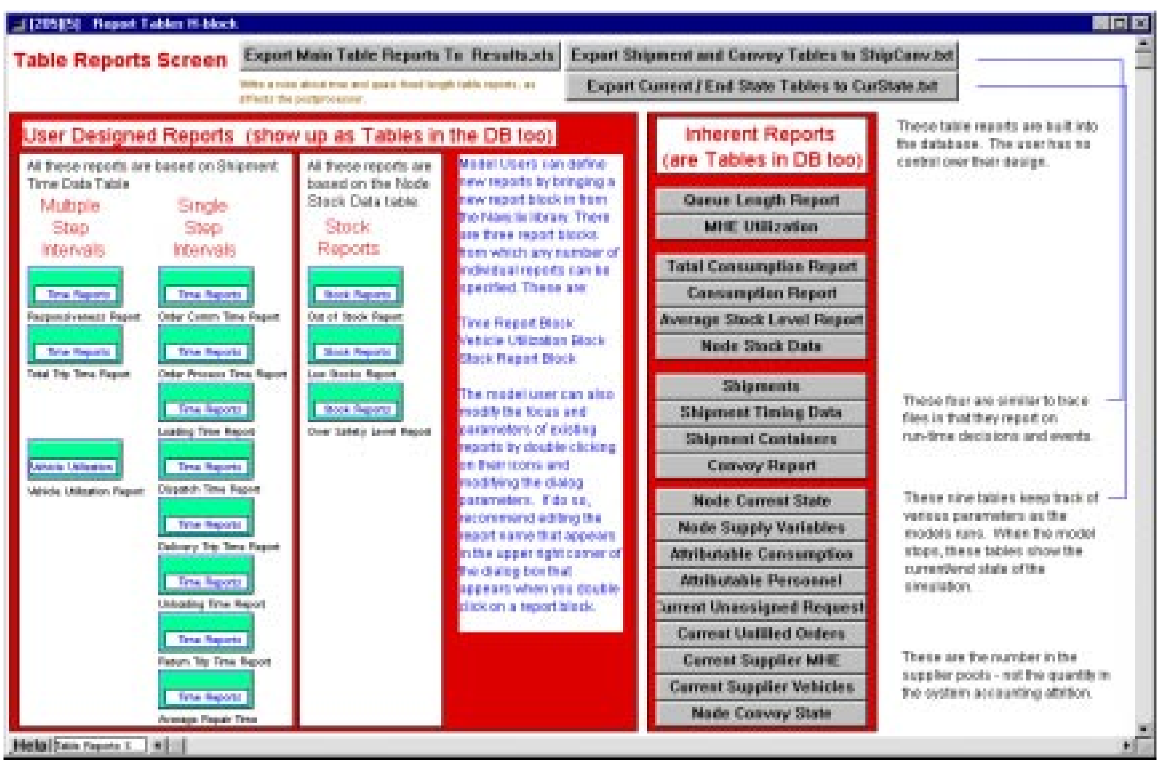


FIGURE 10. Table reports screen.

Case Analysis Workbook

TLoaDS comes with an Excel workbook that post-processes the results many ways. Results are automatically processed and displayed in forms that rapidly assess the operation relative to specified measures of performances. For example, Figure 11 illustrates transporter utilization in a particular field operation simulation. Note how, on the average, the fuel orders had lengthy waits for sixcon fuel transporters, and how the loaded MK48-14 LVS had excessive waits to be dispatched. Note no MK48-17 LVS were sent to Alpha Company during this run. But the shipments delivered by the HMMWV and 5-ton trucks with water bulls were, on the average, received about 40 minutes after being ordered. Average response time for each node by period, or use rate of each transporter by period or node are several of the many other graphical displays automatically presented.

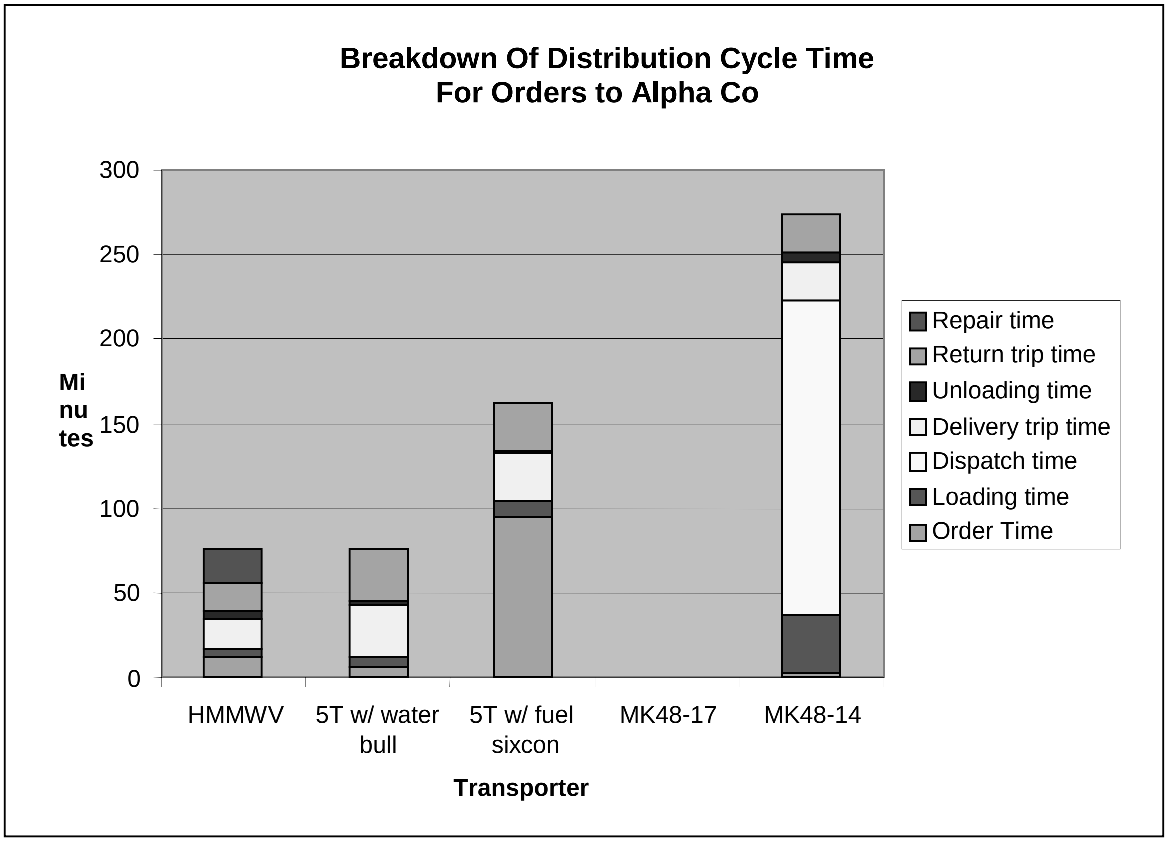


FIGURE 11. Distribution process time by transporter chart.

Multiple cases may also be compared, as revealed in Figure 12, which depicts summary measures of performances relative to other prescribed conditions. Meeting the goal yields 100 index points, reaching threshold yields 0 points, and lesser performance yields negative points.

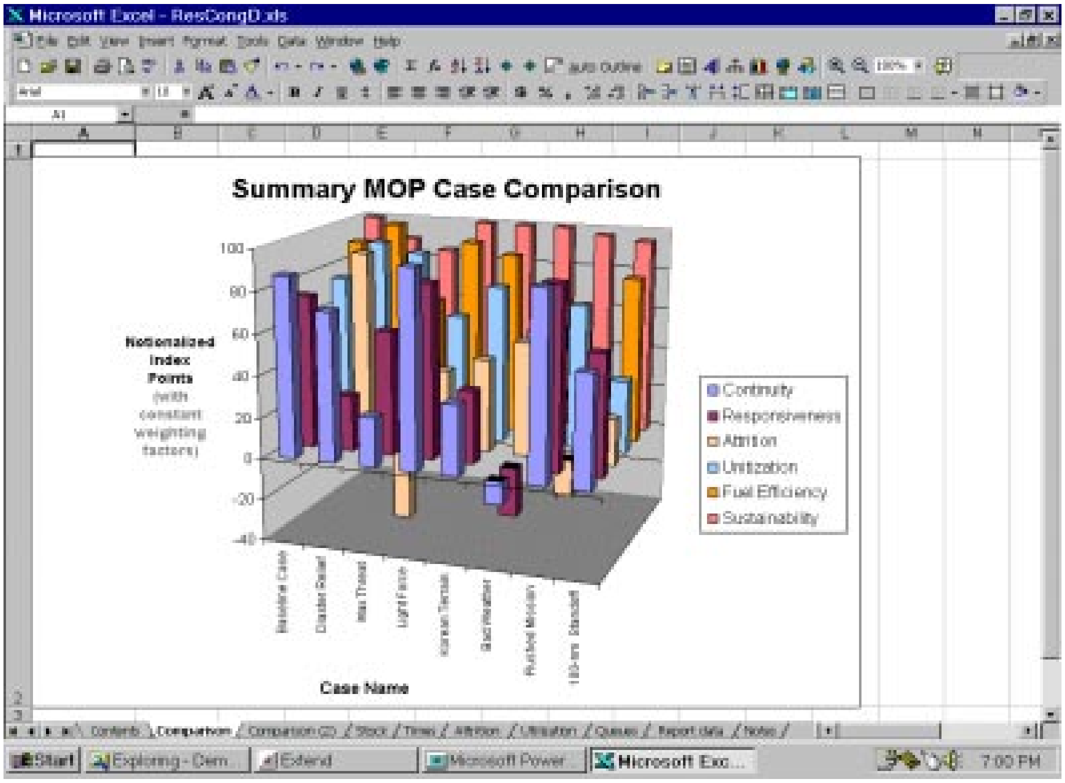
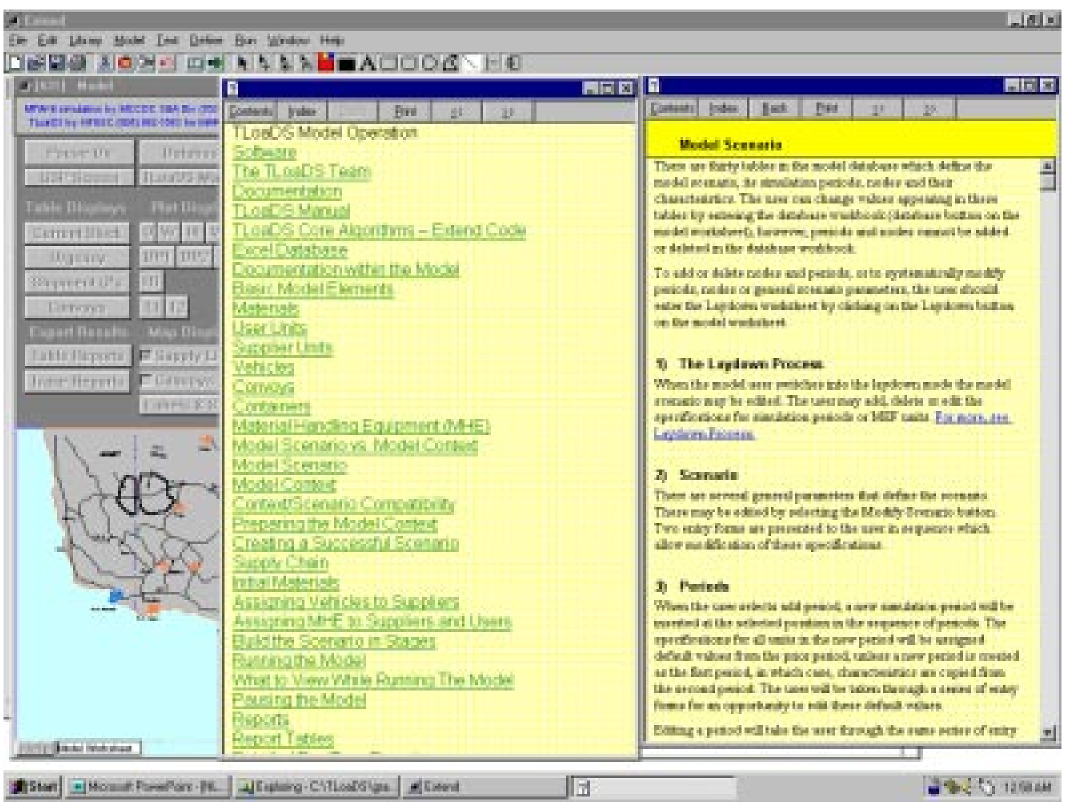


FIGURE 12. Multi-case measures of performance comparison chart.

Help

Another button opens up the on-line help for TLoaDS. It uses the standard help application common to most Windows applications. (Figure 13)



APPLICATIONS OF TLOADS

The simulation tool explores many issues and "what ifs" of tactical logistics. The investigator assesses CSS concepts of operations (e.g., seaming, echelon chain) and techniques (e.g., coordination, prioritization, convoying). Appraised new designs illustrate influence of system integration, supply modularization, and low maintenance equipment. Examining equipment concepts quantify design improvements and lead to capability and quantities needed. Reliability, survivability, and mobility are equally explored.

Measures of performance and effectiveness vary with analyst requirements. Analysts may assess the impact of eliminating BSA/CSSA and resupply of the sea base at sea, trade-offs of a dispersed and localized sea base, size of MAGTF that can be supported by sea basing, trade-off to reduce the logistic footprint ashore, changes to enhance responsiveness, and flexibility. Other analysts may wish to quantify: the impact of commercial helicopters aboard the CLF, the utility of GPADS and Skyhook, the numbers and types of MHEs.

Related issues evaluate the: abilities of ATF to sustain OMFTS operations, competition for MV22, CH53, and LCAC, bulk fuel requirements for OMFTS operations, and stock levels at all sites.

TLoaDS is a constructive model of the Marine Corps tactical distribution system. It can address almost any supply and transportation issue from how the CSSE should reposition its assets if the typhoon turns this way or if the enemy achieves a breakthrough, to what are the pros and cons of new CSS doctrine, tactics, techniques, and procedures, organization, or equipment. It's an artificial MAGTF that students can use to develop their logistics judgment in class, in competition, or on their own.

STATUS AND FUTURE

TLoaDS is at the beta phase of development. It is ready for use by others willing to deal with an unvalidated, unaccredited model that experiences some instability in some installations. The beta user should expect to occasionally receive revised library blocks to correct bugs or add enhancements. These are usually easy to install in a few minutes. Some of the documentation needs updating to reflect recent enhancements.

TLoaDS has participated in war gaming as an adjudication tool. NFESC is currently supporting a couple of TLoaDS beta test sites.

TLoaDS is being expanded to address multiple seabases, integrate UNREP and VERTREP from the CLF, general support, intra-ship movement of supplies, warehousing, and reunitization. This effort is funded by the Office of Naval Research and is referred to as CLoaDS (pronounced 'sea-loads').

TLoaDS is being transformed to simulate the contact maintenance sorties required during a sea based supported OMFTS operation to explore the merits of increasing ground platform readiness and durability. Maintevac and reconstitution may follow. We hope to simulate the assault, troops support and retrograde operations. If we then added medevac and contact engineering simulation to all of the above, we would simulate almost all the competition for key ship to objective lift assets.

Additional simulation and computer-aided collaboration techniques are planned to be integrated into TLoaDS to improve its level of intelligence. One aspect of this will allow the analyst to impart his judgment during a model run, instead of just between model runs. This capability is also needed to improve wargame adjudication.

TLoaDS could be tied in to the Marine Corps tactical C2 systems and become a high quality course of action decision aid for the CSSE and MAGTF commanders. If so, we expect revising TLoaDS' graphical user interface to use the Marine Corps software baseline and work in the Defense information infrastructure common operating environment.

TLoaDS could become HLA compliant so it could work in concert with other models. Discussions of federating TLoaDS with strategic logistic, combat, or command and control simulations have started. Figure 14 presents TLoaDS future inputs, users, mechanism, and outputs.

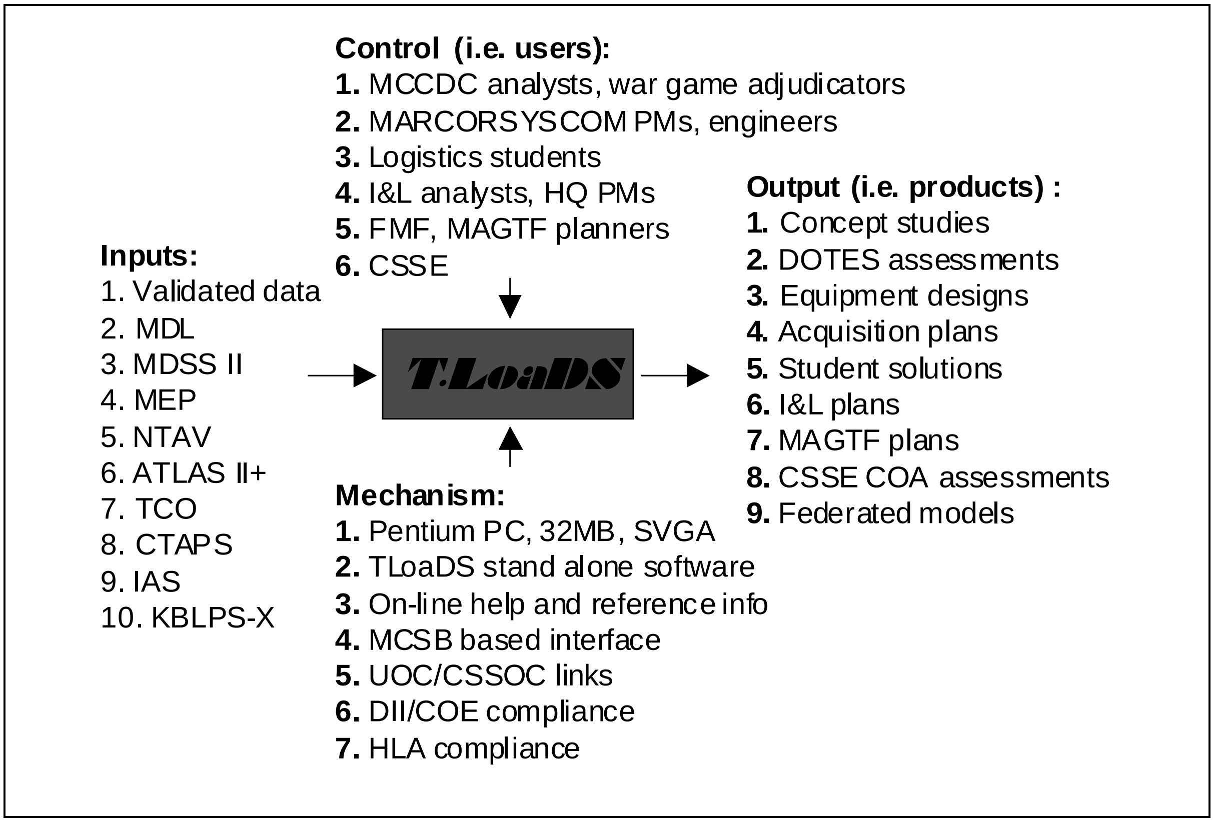


FIGURE 14. Generic USMC use IDEF diagram.

CONCLUSIONS

This paper presents a modeling and simulation tool by which concept developers, planners, engineers, and logisticians can explore the tactical logistic distribution process from sea base to forces ashore and assess the merits of alternative doctrine, techniques, organizations, technology, equipment, procedures, and systems. The simulation of complex processes should permit smarter testing and reduce the cost of field testing of logistic operations. The potential exists to adapt TLoaDS for use as a decision aid for the CSSE in the operational environment, and to federate with other logistics or combat models.

ACRONYMS

ACE	Air Combat Element
ATF	Amphibious Task Force
AWT	Amphibious Warfare Technology Directorate
BSA	Beach support area
CLF	Combat logistics force
CLoaDS	Seabased Logistics Distribution System
CSS	Combat service support
CSSA	Combat service support area
CSSOC	Combat service support operation center
COTS	Commercial-off-the-shelf
EAF	Expeditionary air field
FCSSA	Force combat service support area
FARP	Forward arming and refueling point
GPADS	Guided parafoil airborne delivery system
HLA	High level architecture
HMMWV	High mobility multipurpose wheeled vehicle
ISP	Intermediate support point
LCAC	Landing craft air cushioned
LCU	Landing craft unit
LZSA	Landing zone support area
LVS	Logistic vehicle system
MHE	Material handling equipment
MCSSD	Mobile Combat Service Support Detachment
MEF	Marine Expeditionary Force
MAGTF	Marine Air-Ground Task Force
MOPP	Military oriented protective posture
NFESC	Naval Facilities Engineering Service Center
NIMA	National Imagery and Mapping Agency
NEO	Non-combatant evacuation operation
NSWC-CD	Naval Surface Warfare Center, Carderock Division
OMFTS	Operational Maneuver from the Sea
ONR	Office of Naval Research
POD	Port of debarkation
RRP	Repair and replenishment point
STOM	Ship to Objective Maneuver
SOA	Sustained operations ashore
TLoaDS	Tactical Logistics Distribution System
TIH	Transporter integrated handler
UNREP	underway replenishment
VERTREP	vertical replenishment

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Bob Hamber is responsible for TLoaDS vision, requirements, initialization, first line user technical support, and teaching the training courses. He is a logistician and systems analyst in the Expeditionary Systems Division at the Naval Facilities Engineering Service Center, Port Hueneme, California. He has 13 years experience developing tactical logistics equipment and conducting CSS systems engineering for the Marine Corps Systems Command.

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