AUTOMATION OF A STRADDLE-CARRIER OPERATION

Erik D'Hondt
Hessenatie, N.V.
Port of Antwerp

INTRODUCTION

Hessenatie, Antwerp's major stevedoring company, had a market share of 45 percent of the port's general cargo traffic in 1993. In addition, 900,000 boxes were handled at the port's various terminals. The riverside Scheldt Container Terminal (to date the only Antwerp terminal outside the locks) is the most recent facility to be built (Fig. 1). Opened in 1990, the terminal handled 223,000 containers in the first half of 1994, using six super-Panamax gantries.

PRODUCTIVITY AT THE SCHELDT TERMINAL

Out of every 10 crews that work a full 8-hr shift on the same vessel, nine achieve a throughput of more than 200 moves (gross) or more than 250 moves (net). Normal mean productivity figures are 245 and 280 moves, respectively. This throughput is in line with Hessenatie's productivity level. Typical in-house standards for container operation are 100,000 moves per gantry year with a minimum reliability in operation of 99.5 percent and straddle-carrier fleet use of 40,000 moves per machine per year with a minimum reliability in operation of 95 percent.

Hessenatie is dedicated to an operation that uses straddle-carriers for all tasks, except for handling empty containers. Although the machine is complicated and expensive to maintain—15 min maintenance time as required per hour working time—its flexibility in operation is unrivaled. In our region of the world, where competing ports are hardly 100 km away, flexibility is a prerequisite for successful terminal operation.

Ship operations start on arrival because swift intermodal interchange operations are expected (e.g., truck dwell times inside the terminal are expected to be less than 1 hr, from roadside to roadside). Figure 2 demonstrates the situation on a very busy day, July 20, 1994. Trucks with a dwell time of more than 1 hr came in before meal break. Our location and the very competitive environment induce a level of uncertainty that makes accurate planning of personnel and equipment usage difficult. For example:

- Vessels with a short sailing time often come from a neighboring port (from Felixstowe, 12 hr; Le Havre, 17 hr; Rotterdam, 12.30 hr). Any delay in handling at these ports or on the journey in between is reflected directly reflects in the estimated time of arrival (ETA).
- Trucks were initially estimated to account for 70 percent of intermodal traffic. In spite of traffic congestion, they now account for 85 percent. Their arrival patterns are unpredictable (Fig. 3), and late arrivals tend to become ever more popular. Political measures with regard to road traffic might reverse this trend drastically. No target date can be set; we only need to be prepared.
- In spite of all the rhetoric on rail-traffic promotion, its market share experienced a continuous decrease from 10 percent in 1990 to around 5 percent today.
- Barge traffic today constitutes around 20 percent of intermodal traffic. One year ago it was half this amount.

None of these circumstances are exceptional in container-handling practice. Their combination and our competitive situation only clarify Hessenatie's urgency for a simple, flexible, cost-effective, and reliable terminal operation.

OPERATION SYSTEM: AUTOMATED?

If a terminal is to be flexible, it has to be manual. However, in view of the recent technological developments and the wage level of the dockers (basic wage cost for a crane driver is $325 per 8-hr shift in Antwerp), it is tempting to investigate the conversion of an existing terminal to automated physical handling. Hessenatie investigated terminal conversion in detail and concluded that it is not possible under present circumstances.

First, a terminal is as productive as its dockers. No system we investigated could attain the present productivity figures mentioned previously. The dedication of the Antwerp docker to do the job well and in time is a feature we will discard reluctantly.

FIGURE 1 Aerial view of the Scheldt container terminal.

Second, an automated system is ideally suited to repetitive actions, assuming a stable cargo flow. The peak-to-mean ratio's at the various terminal interfaces are so high that an excessive investment would be required to maintain the present service level even at peak periods. As mentioned previously, our in-house standards for equipment use are fairly high—in general around 35 percent for all types of equipment.

Third, with regard to safety, automation is only feasible in a grass-roots, developed facility. Any partial automation, such as the various proposals for unmanned shore gantries, invariably fail when the subject of safety of lashers and ship's crew is raised.

Finally, in terms of cost-efficiency, terminal conversion is not feasible. No two terminals are alike but a general indication may be given when automation of stacking is considered. In an efficient straddle-carrier system, the direct cost of a single straddle-carrier round trip—two transport and one stacking moves—is composed of the following:

- Capital cost (10-percent interest rate assumed), 27 percent;
- Wage cost-operation, 27 percent;
- Maintenance, 15 percent;
- Spare parts and fuel, 14 percent;
- Information systems, 13 percent; and
- Miscellaneous, 4 percent.

If the elimination of the operation's wage cost is pursued through automation and assuming that the same stacking capacity per m^2 is least maintained, the capital cost of the automated system should not more than double to attain the cost level recorded today. No investigated automated system in comparison with a

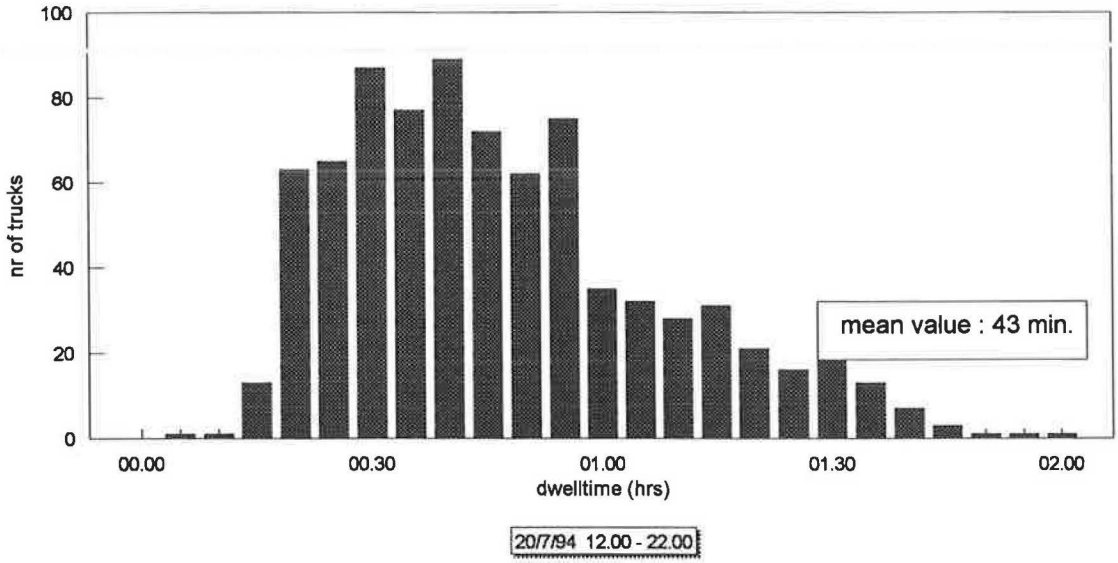

FIGURE 2 Scheldt container terminal: truck dwell times.

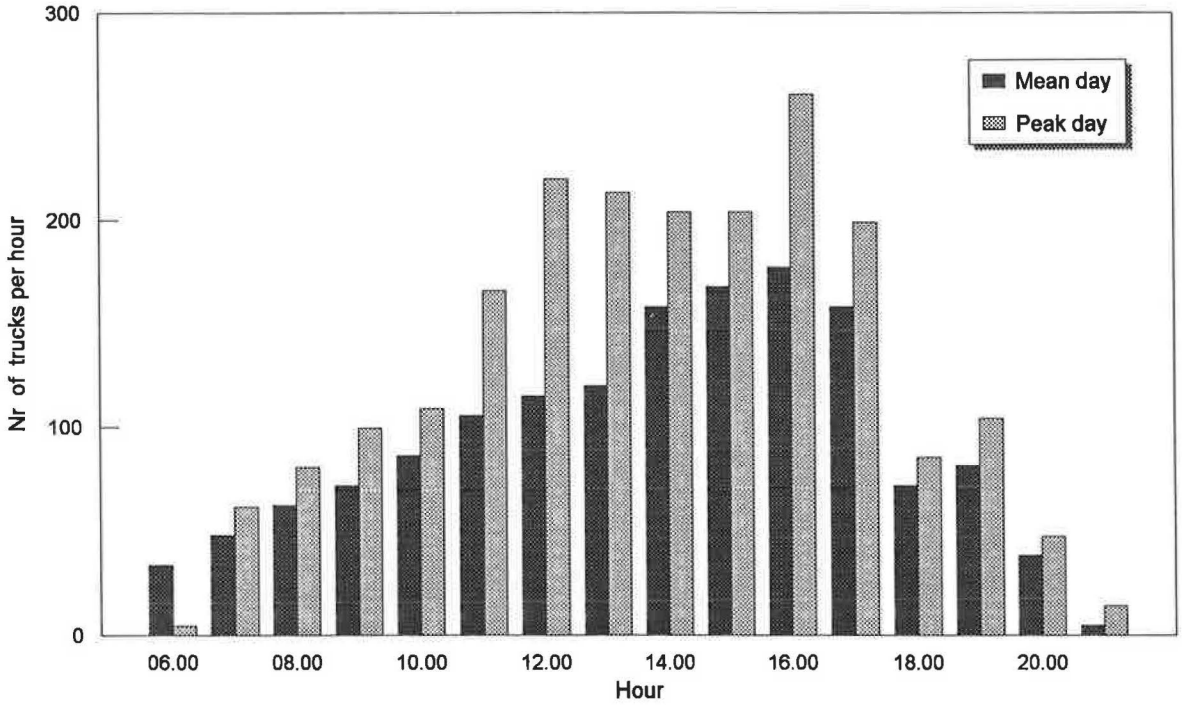

FIGURE 3 Scheldt container terminal: typical truck arrival patterns.

direct straddle-carrier system could achieve this. The maintenance cost provides a positive cost margin because a well-conceived automated system is likely to be less expensive to maintain than a straddle-carrier system. The cost of the information system, on the other hand, is most likely to increase substantially both in terms of investment and maintenance when the physical handling of containers is automated.

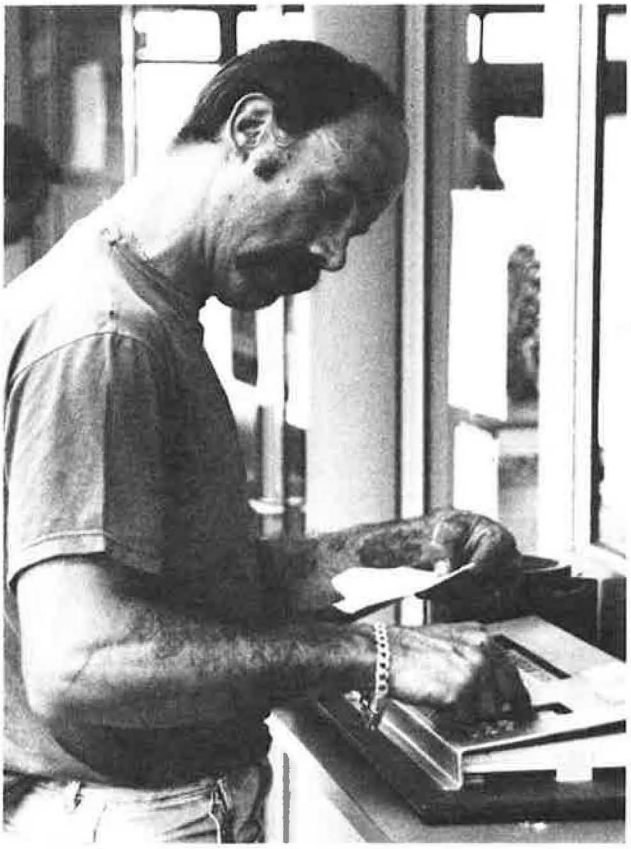

FIGURE 4 Automated data entry by trucker.

CONTAINER TERMINAL CONTROL SYSTEM

If the time for full automation is not right yet, automation of associated information flow definitely is. In 1993 Hessenatie introduced to the Scheldt Container Terminal the all-encompassing Container Terminal Control System (CTCS). It is the latest version of the control system Hessenatie has been developing in-house since 1982.

CTCS consists of many modules working on a central data-base server, TERMWARE, which centralizes all data-base I/O's, guarding data consistency and reliability.

Apart from typical administrative modules (Fig. 4), CTCS's aim is to control various operation phases via three modules—SPACE, TRAFIC, and SHIPS. All modules are fully integrated, and electronic data interchange is available. All modules were conceived by COSMOS N.V., an information technology subsidiary of Hessenatie which markets them all over the world.

SPACE

SPACE ensures optimum organization of the container yard. The ultimate goal is to handle every box two times only: once to put the delivered container in the stack and once to take it out for loading. At the same time, the stacking density must be maximized.

To ensure short distances between the container and the handling gantry, SPACE continuously keeps track of the planned berth of the vessel. Export containers for the corresponding vessel will be placed in the yard according to the last planned berth position. The process usually results in positioning of the containers within the perimeter of the vessel.

To ensure high stack density, containers with the same characteristics are put together, even on top of one another. When a container is placed on top of another, its weight should not exceed the weight of the box underneath.

To reduce the amount of space that must be reserved, the reservation of space is adapted to the delivery pattern of the containers for the container line under consideration (based on records). Consequently, the space in the yard reserved for export containers will increase in accordance with proximity to the ETA of the vessel.

TRAFIC

TRAFIC is a fully automatic tool that increases the productivity of straddle-carriers, empty container stackers, and any kind of transporter to an absolute maximum, especially in a busy working environment. TRAFIC issues transporter move instructions by means of radio-linked data terminals. No data have to be entered by the driver; all communications with TRAFIC are effectuated via precoded messages, such as "job executed," "request new job," and "truck not present." The container-move instruction can be entered into TRAFIC in several ways: in a defined sequence, such as the loading sequence generated by SHIPS, or as single instructions, such as for loading and discharging trucks.

TRAFIC incorporates an advanced planning process based on a "look ahead" technique that performs planning for the next four moves whenever a transporter requests a new instruction. This reduces long, "empty" driving distances and spreader length changes. TRAFIC also generates shifting moves in the yard. The planning process reduces container congestion under the gantry crane and contention between transporters headed for

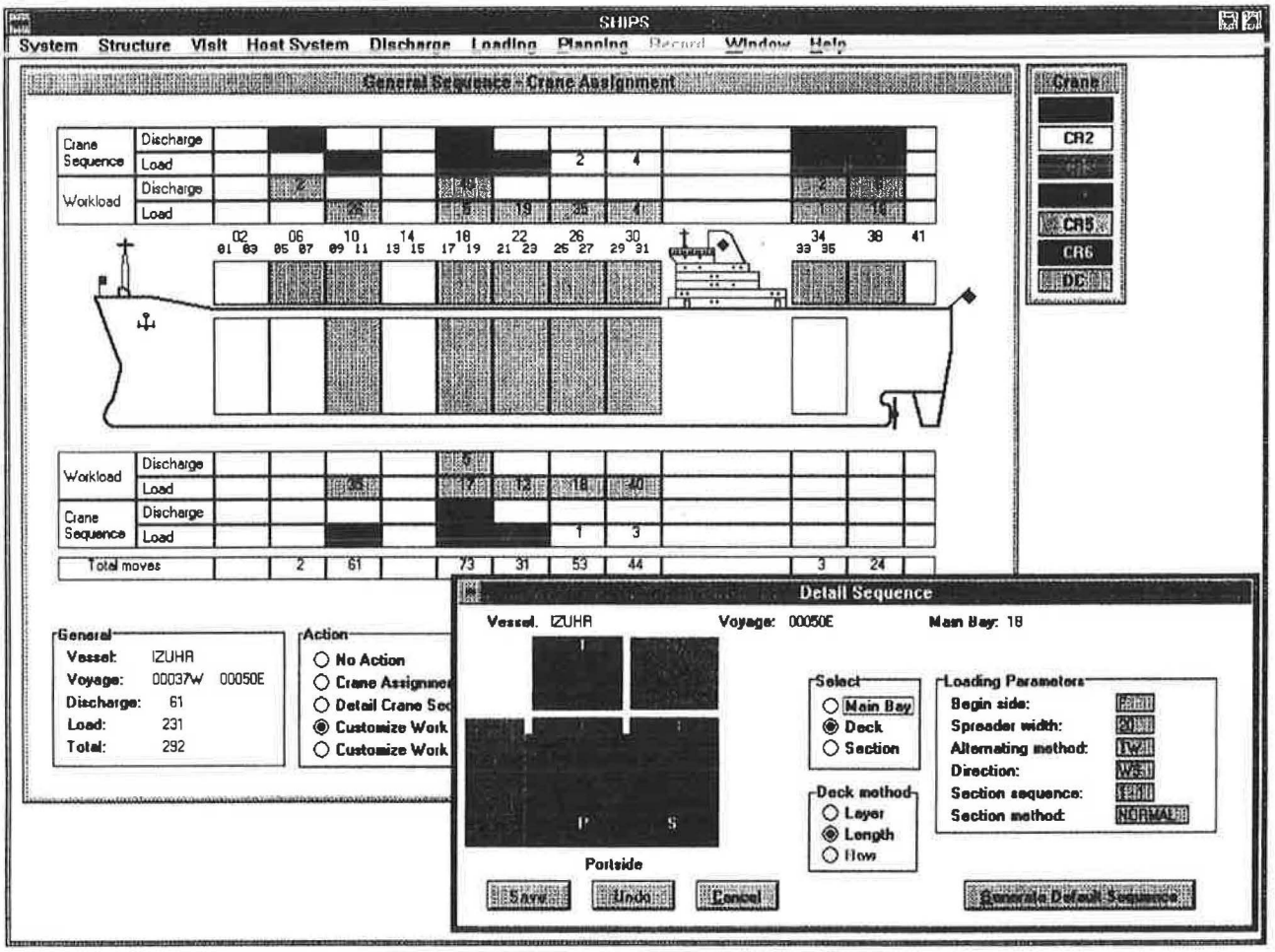

FIGURE 5 SHIPS computer screen.

the same container row. And last but not least, TRAFIC results in spreading the dwell time of visiting trucks evenly. No physical control of the executed jobs is done; this proved to be superfluous in practice.

SHIPS

SHIPS, a software package that performs fully automatic and accurate planning of a vessel, guarantees the best vessel stability by reckoning with prestow specifications, international segregation rules for hazardous goods, and many other parameters (Figs. 5–7). The productivity of container terminal operations increases considerably because SHIPS minimizes the number of shifting moves in the yard. Because of the very fast automatic planning process (about 1,000 containers in 3 min on a 486 DX, 33 MHz processor), the planner can simulate several work scenarios and calculate the number of shifting moves in the yard for several settings of the planning parameters. The selected planning, resulting in container sequence lists per bay, can be uploaded to TRAFIC to perform transporter guidance.

OPERATIONAL RESULTS

The direct effect of total computer control is difficult to define in absolute figures. In general terms, however, the introduction of CTCS enabled Hessenatie to simultaneously maintain its equipment-use standards and the service level to its clients in an ever busier working environment.

The effect of an individual module such as SHIPS is easily visible because it can be translated in the required workforce. For Hessenatie, a 35-percent improvement in ship planners' efficiency was recorded after the model was introduced.

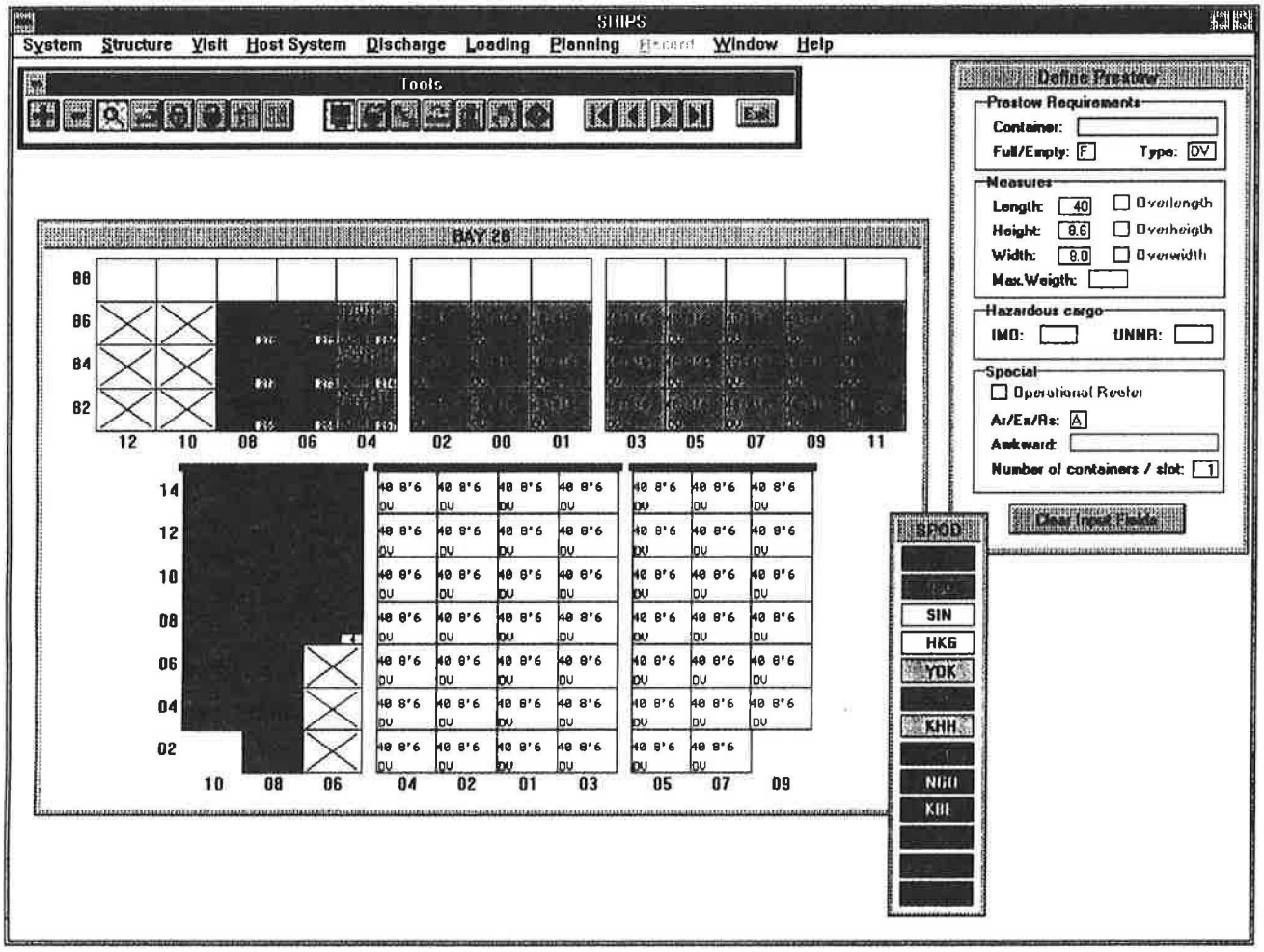

FIGURE 6 SHIPS computer screen.

The introduction of TRAFIC definitely enhanced the productivity of the straddle-carriers. Although 135 moves per straddle-carrier shift are by no means exceptional (but travel distance always has to be taken into account), compared with a manual system with voice radio instructions, a 100-percent increase in productivity may safely be assumed. The result is that Hessenatie was able to handle 450,000 containers with 28 straddle-carriers for all full-container operations (quay side, truck interchange, stacking, rail loading, and barge operations) in 1994 at the Scheldt Container Terminal.

CONCLUSION

Cost-effective automation today is still confined to administration and planning. Automation of the physical handling of containers may very well be the next step, but only under the following conditions:

- Cargo flow is stable over the project period.
- Present service levels are maintained and even enhanced, particularly in unpredictable peak conditions.
- The cost-efficiency of the automated terminal is increased.

In Hessenatie's view, automation of the terminal is not the vital element for success in the present situation. Given good accessibility for vessels, the intermodal connections of a terminal, by far, are more important.

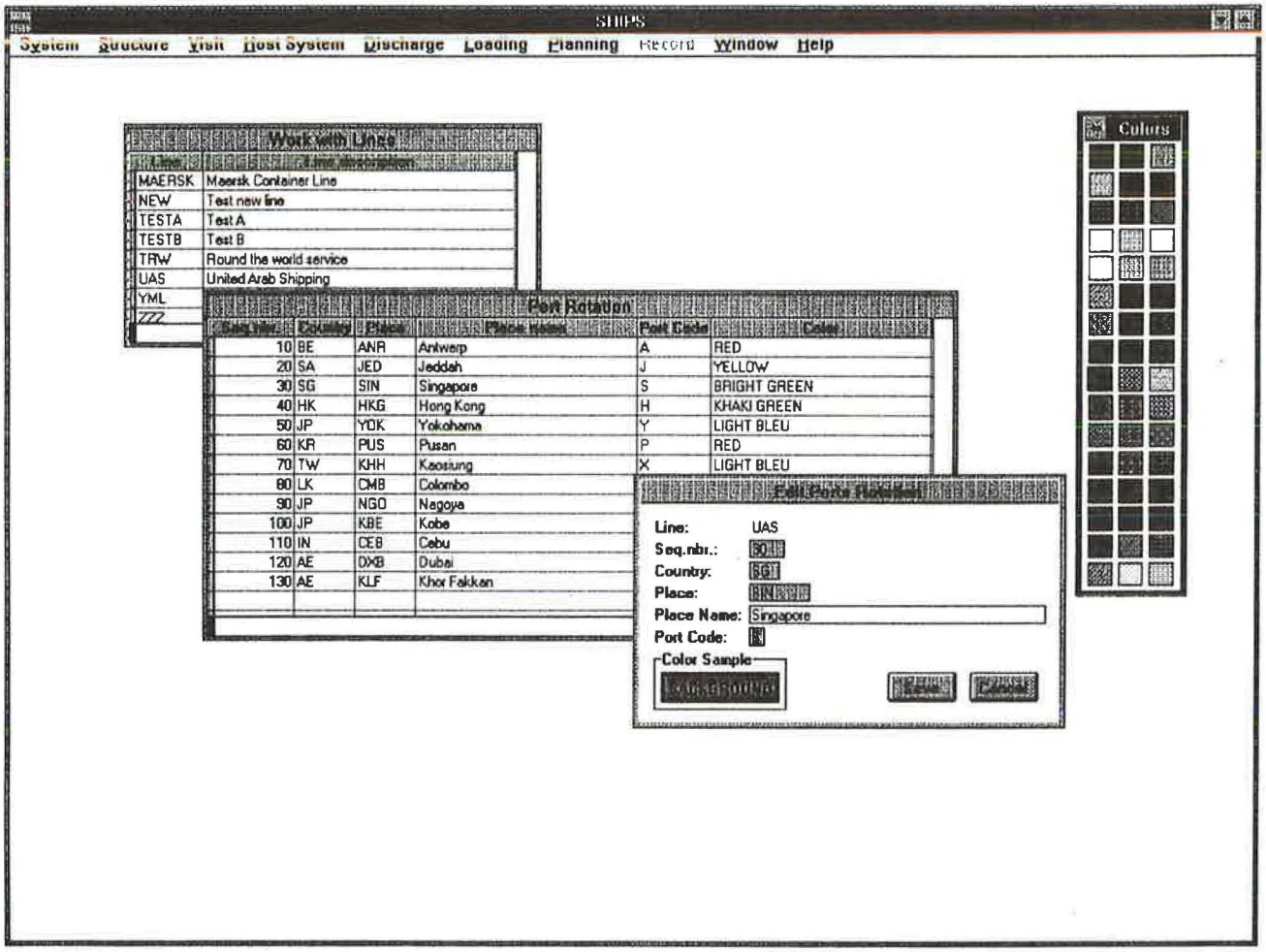

FIGURE 7 SHIPS computer screen.