INTERMODAL TRANSSHIPMENT FACILITY SIMULATION - A CASE STUDY

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INTRODUCTION

This paper summarizes the philosophy and techniques underlying the development and subsequent application of a simulation model to provide data essential to a cost and performance analysis of an intermodal dry bulk commodity transshipping terminal. The use of the model assists the materials handling engineer or transportation analyst in quickly evaluating alternate system configurations and component sizes under various conditions and loads.

The transshipping terminal provides the crucial interface between the different transportation modes present in an intermodal haulage system. For this reason, it is essential that the terminal be evaluated in the context of the entire transportation system (Reference 1). A broadened and comprehensive approach is necessary wherein each component of the network is viewed as equally important.

The integrated intermodal transportation system, as modeled, is composed of servicing components at the mines or plants for train loading; at the transshipping terminal for train unloading and vessel loading; and at the destination for vessel unloading. The unit trains, used for the commodity movement from the mines or plants to the transshipping terminal, consist of dedicated sets of locomotives and cars designed to operate as an entity. The vessels used for the water borne movement are typically high capacity, high speed vessels, often designed with integral self-discharging systems for fast, efficient unloading at the destination.

The terminal is a vital component in the overall haulage system. Unless the terminal is designed with a careful analysis of its performance relative to the intended operating environment, the potential of the unit trains and vessels may never be fully realized. Any delays at the terminal could dramatically affect the economies of the rail and shipping links. The design of the terminal must accommodate the day-to-day transfer of material and the associated fluctuations in the input/output flow. An additional buffering capacity is also required in those locations where the navigational season is restricted if the unit train and mine or plant operations are to continue year round. This results in a complex surge and buffering operation which requires comprehensive, in-depth analysis to determine an effective solution.

The model developed by ORBA was designed to facilitate in the analysis of a terminal with both surge and buffering capacities. The terminal design incorporates a "live" storage area to accommodate the day-to-day operations. The buffering required for substantial time lags between shipping and receiving is provided by "dead" storage.

To illustrate the buffering problem, consider the following. Assuming a shipping season of eight (8) months and a receiving period of twelve (12) months, approximately 33% of the annual throughput would be accumulated in on-the-ground dead storage during the four (4) winter months as shipping ceases. Upon commencement of the shipping season, all material received would be routed to vessels whenever possible. The input flow routed to vessels must be augmented by a steady depletion of the dead storage piles to meet the required output flow. Assuming an eight month shipping season, an average of 67% of the material required to load a ship would be routed from trains (either directly from train to vessel or from train to live storage to vessel) and 33% of the material required to load a ship would be reclaimed from dead storage accumulated during the winter months to augment the input flow from trains.

Many designs are possible to provide the necessary receiving, shipping and storage capabilities. It is difficult to evaluate the overall cost and performance implications of one configuration as opposed to another. A simulation of the various configurations and component capacities provides a rational basis for comparison (Reference 2).

IMPLEMENTATION LANGUAGE SELECTION

Because the flow paths and rates within the terminal change dynamically based upon the storage levels and the system status, the material movement within the facility from one area to another must be represented as a continuous process. The flow rates and/or paths change discretely based upon continuously changing storage levels. The train and vessel movements to and from the facility are discrete events.

GASP IV was chosen as the implementation medium because it provides flexibility to enable the dependent system flow rates and paths to change discretely based upon continuously changing storage levels while providing discrete event capabilities to mimic the train and vessel movements. GASP IV provides the key functions of event control, continuous variable updating, system initialization and program monitoring for the user (Reference 3). Now to the specifics of the model.

CONTINUOUS ASPECTS OF THE MODEL'S IMPLEMENTATION

The material movement within the terminal is represented in the model by using continuous techniques. State variables are used to represent all continuously changing terminal attributes. These constantly changing attributes include the levels of the storage piles and the contents of the train(s) unloading and the vessel(s) loading. Each is represented by a state variable accessible by a unique index. The number of storage areas to be represented is a function of the terminal's design requirements. The material is stored within the terminal by commodity number. Each terminal customer's material may be stored in separate areas if required by assigning unique commodity numbers.

The material movement is mimicked by establishing the attribute values of a flow path and rate for each specific servicing entity which moves material within the terminal. The flow path for each material movement subsystem defines the source and destination of the material being moved by identifying the index of the state variable representing the respective piles. The rates associated with each subsystem include a maximum rate equal to the design capacity of the component, an allowable rate possible at a specific instant in time and the actual rate in effect. The maximum rate is an inputed constant indicating the maximum design capacity. The allowable rate is modified due to equipment failures and/or availabilities but it is always less than or equal to the maximum rate. The actual rate denotes the current rate of material transfer occurring at any instant in time. The actual rate is always less than or equal to the allowable rate. The actual rate for the system changes discretely based upon the flow path and the continuously changing storage levels.

The state variables representing the various piles are updated when GASP calls the user defined routine STATE. The flow rate for each material movement subsystem is evaluated and the amount of material moved during the time increment is added and subtracted from the respective piles (state variables) as defined by the flow path.

Certain conditions of the continuously changing terminal attributes require action. These conditions include reaching the maximum or minimum level of a storage pile or the amount of material in a train being unloaded reaching zero or the amount of material in a vessel being loaded reaching the desired cargo level. GASP calls the user defined routine SCOND to determine if one or more of these conditions has occurred thereby causing a state-event. GASP uses the variable ISEES set in SCOND to communicate whether or not a state-event has occurred. When a state-event is detected, GASP automatically calls the user routine EVNTS with the event code for the state-event decoding module.

The state-event or events that occur are determined by the user examining the flags set in SCOND. A test is made to determine if the contents of the train unloading has reached zero. If so, the completion of a train unloading is simulated by a call to the event routine which performs the required activities. A test is then made to determine if a ship has completed loading. If so, the routine simulating the activities required when a vessel loading is completed is called. A final test is made to determine if a storage problem has been detected. If so, the "routing" algorithm is activated to reallocate the terminal's resources as is necessary. Sequential testing of the various flags is necessary as more than one condition may occur simultaneously.

The routing algorithm embodies the entire logic flow and operating procedures specific to the terminal. All priorities for the allocation of the facility's resources are incorporated in the algorithm. The ship loading function has priority over train unloading operations. If both are competing simultaneously for the same servicing component, the ship loader is given preference. Material movement in anticipation of an impending arrival has the lowest priority and is performed during idle periods. An example of this type of activity would be moving material into the live storage area prior to a vessel's arrival when the anticipated pile level is not sufficient for vessel loading.

Modeling different terminal flow configurations necessitates a modification of the "routing" algorithm. Various designs generally would involve changing the flow paths. For example, one terminal design might allow material to be transferred directly from the car dumping area to either live or dead storage area. Whereas, another design may transfer all incoming material to the live storage area and use another system to move material from live to dead storage. To effect the necessary modification, new flow path choices for the car dumping and stockpiling system are incorporated into the "routing" algorithm. More substantial configuration changes may be made easily due to the modular construction of the model itself.

DISCRETE ASPECTS OF THE MODEL'S IMPLEMENTATION

The simulation of the train and vessel movement to and from the terminal is obtained by using an event modeling philosophy to facilitate an analysis of the queueing problem and its effect upon the train and vessel cycles. The routines required for representing the trains and the ships are quite similar, thus, for brevity the discussion will be limited to modeling the train movements, as they are more complex.

The event for the completion of a train unloading operation at the terminal is a state-event caused by the contents of the train reaching zero. Within the event routine for the completion of unloading, the train currently completing unloading is removed from the file used to save its attribute values. Statistics on the unloading time and rate are updated and the unloading system's status is set equal to "not busy." The routing algorithm is then activated to reset the flow rates and paths. The activities required to model the train's exit from the terminal are a function of the track layout associated with the terminal. If the exit path is such that no blocking conditions may occur, then the routine calculates the transit time and schedules the train's arrival at the appropriate mine. If the train's exit path involves possible blocking, then the train's arrival at the blocking position is scheduled. Although not specifically stated, many different switches may be required to indicate the train's location on the loop track. As the complexity of the loop circuit increases, the modeling effort becomes substantial. This level of detail is required only if precise data on the blocking conditions is needed.

The routine which does the event processing for a train's arrival at the mine is scheduled when the train exits the terminal. The mine number is determined by examining the attributes of the train. The arriving train is placed in the appropriate mine's loading queue and the queue statistics are updated. Data is also collected on the transit time. An attempt to load the train is scheduled to occur immediately.

An event signifying an attempt to load a train at the mine is scheduled whenever the loading facility becomes free or a train arrives for processing. When an event signifying an attempt to load occurs, the status of the loading facility is interrogated. If the loading facility is busy, no action is taken and control is returned to GASP. If the loading facility is free, the queue is examined to determine if a train is waiting. If no train is awaiting service, control is returned to GASP. If there is a train waiting and the facility is not busy, the train in the waiting queue is removed and the queue statistics updated. The queue structure may be varied on input to be ranked by user number, arrival time or a service factor as desired. The mine loading facility status is set to "busy." The loading time is computed and the completion of the loading activity is scheduled at the current clock time plus the loading time. Control is then returned to GASP after collecting data on the loading rate and time.

The event signifying a completion of the train loading at the mine is scheduled when the loading is initiated. When the event occurs, the status of the loading facility is set equal to "not busy." An attempt to load at the mine is scheduled immediately. The arrival of the train at the terminal is then scheduled. A delay associated with processing at the mine is included to be representative of those delays caused by other mine customers which are not simulated by the model.

The event for processing train arrivals at the terminal varies depending upon the track configuration. The number of trains which may be present on the loop track simultaneously must be determined. The track configuration must also be examined for possible blocking or interference points. When a train arrives at the terminal's boundary, a check is made to determine if the train may advance onto the property. If conditions within the terminal permit, the train's arrival at the holding area is scheduled. Conditions are checked to determine if entering delays occur and the travel time is modified as required. If an actual blocking condition may occur, the train's arrival at the blocking location is scheduled. Several different queues may be present at the terminal representing the blocking locations. A queue of finite size exists representing the holding areas on the loop track. Trains that cannot be processed directly on the loop circuit because it is filled to capacity are placed in a secondary receiving queue outside the terminal. If interference occurs between a train indexing through the dumping cycle and an exiting or entering train, the train indexing is given the right of way. Under no circumstances is the path of an indexed train obstructed by an entering or exiting train. When the location of an indexing train must be determined to establish the route of another train, its location is calculated by examining the amount currently remaining in the train relative to its initial contents. Once the arrival of the train at a holding area is scheduled, control is returned to GASP.

The event routine for processing a train's arrival at a holding area automatically places the train in the appropriate holding queue. An attempt to advance the train to the next checkpoint is scheduled immediately. The path of the train to the unloading facility is dependent upon the actual track configuration. As a train successfully exits a checkpoint, actions are initiated to advance another train. This technique of passing the train through various checkpoints allows a dynamic routing of the train within the terminal as conditions require. After passing a final checkpoint, the arrival of the train at the unloading system is scheduled.

The preceeding discussion of the train's advance through the various checkpoints is based upon removing trains from each queue on a "first-entry/first-removed" basis as ranked. The ranking may be by user number, arrival time, commodity number or service factor. If the terminal has more than one train unloading system, a more elaborate entering procedure is required. For example, if the terminal has three train unloading facilities, and each facility handles only certain specific commodities, a decision must be made as to which specific system is to be utilized. This implies that the path of the train is determined by the commodity carried in relation to the configuration of the specific commodity flows. The allocation of commodity storage at each servicing facility may have a dramatic effect on the overall terminal performance.

The event for the arrival of a train at the unloading facility is scheduled as the train exits the final entering checkpoint. The status of the unloading facility is set to "busy." The attributes of the train are stored in a file to save critical data. The value of the state variable representing the contents of the train unloading is set equal to the train payload. The "routing" is then activated to establish a flow path and rate for the train unloading system. The completion of the unloading activity is not a scheduled event. It is a state-event detected when the contents of the train unloading has reached zero. It is essential that the train's attributes be stored in a file as no event was scheduled which would preserve the train's attribute values.

The events required to mimic the vessel's movement are quite similar to those for the train movements to and from the facility and hence no further clarification is necessary.

GENERAL APPRAISAL OF THE IMPLEMENTATION APPROACH

The implementation approach used enables a modular construction of the model which facilitates modification. Any particular aspect of the model is easily changed as the design of the terminal evolves. Each aspect of the terminal's function is detailed within the model to provide the necessary performance data as required without effecting major changes in the actual program.

One significant drawback is that the development of such a model requires programming abilities combined with a knowledge of both transportation and material handling systems. The time constraints involved in developing or modifying such a model usually require the talents of an individual capable of performing both the design analysis and programming to achieve the timeliness of the results.

APPLICATION OF THE SIMULATION MODEL

The simulation model provides valuable data and insights about the effects of utilizing different component sizes and capacities. This is particularly true when sizing the live storage area. There are definite cost trade-offs between various live storage capacities and the live-to-dead and dead-to-live transfer modes and rates. Degradation of the material caused by excessive handling may also become a critical factor with some commodities.

The live storage capacity which is necessary to reduce the double handling of incoming material received during the shipping season is related to the frequency of vessel calls, the vessel cargo tonnages and the operating procedure for augmenting the input flow from trains to meet the shipping demands. By examining the output produced by a simulation run depicting the operating configuration, the tonnages requiring multiple handling may be determined and costs assessed. The combined effect of the live storage size and the handling rates of the system (in terms of tons per hour) providing the live-to-dead and dead-to-live material transfer may dramatically affect the train unloading and/or vessel loading rates. For example, if a train is to unload and the live storage area which must receive the material is full, the train may not unload at a rate greater than the rate of which material may be withdrawn from the receiving pile regardless of the unloading system's rate. If the support systems for the material movement into and out of the live storage area are busy with a loading vessel, the train unloading rate would drop to zero. Similarly, if the contents of live storage is not sufficient to load the vessel, the loading rate may deteriorate due to insufficient material transfer rates from dead-to-live storage.

The problems depicted above are representative of those which the simulation output indicates, but they are by no means exhaustive. The interaction of the various system components produces subtle consequences which would defy prediction by any technique other than simulation. The simulation model may be used to provide performance data for numerous combinations of storage capacities and component sizes to facilitate a more rational basis for design decisions. Simulation modeling allows the system designer to efficiently use his judgement by providing assurances as to the logical and inevitable consequences that result from his decisions.

The use of the simulation model as an analysis tool need not be confined to the design stages. The model provides value insights into the terminal's ability to respond to various customer loads and configurations. The effect of adding additional customers to an existing terminal may be assessed to enable management decisions regarding future facility usage. For example, if the proposed addition of another customer deteriorates processing of the existing customers, the per ton charges of the customers may be adjusted accordingly to compensate for the changing performance characteristics as indicated by the simulation output.

The output generated from a simulation model is determined by the user's requirements. Depending upon the items of interest, the type of output produced may vary substantially. Several excerpts from a representative application are included to illustrate the type of output reports which may be generated.

Many possible areas of application exist. The potential of the simulation model to provide data to assist in decision making is limited only by the vision of the user.

REFERENCES

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3. Pritsker, A. Alan B., The GASP IV Simulation Languages, John Wiley & Sons, New York, New York, 1974.

4. Reitman, Julian, Computer Simulation Applications, Wiley-Interscience, New York, New York, 1971, pp. 1-26.

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*                                 SUMMARY OF TONNAGES PROCESSED AT THE FACILITY BY USER NUMBER                                 *
*                                                                                                                              *
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*      *                             *                             *                             *                             *
*      *      TONNAGE UNLOADED       *        TONNAGE LOADED       *   TONNAGE DOZED OUT OF LIVE *  TONNAGE DOZED INTO LIVE    *
*      *                             *                             *                             *                             *
* USER *************************************************************************************************************************
*NUMBER*         *         *         *         *         *         *         *         *         *         *         *         *
*      *  SYSTEM *  SYSTEM *  TOTAL  *  SYSTEM *  SYSTEM *  TOTAL  *  SYSTEM *  SYSTEM *  TOTAL  *  SYSTEM *  SYSTEM *  TOTAL  *
*      *    1    *    2    *         *    1    *    2    *         *    1    *    2    *         *    1    *    2    *         *
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*      *         *         *         *         *         *         *         *         *         *         *         *         *
*   1  * 3561057.*  123031.* 3684088.* 2133047.*  206568.* 2339614.* 1828112.*       0.* 1828112.*  302478.*   65251.*  367729.*
*      *         *         *         *         *         *         *         *         *         *         *         *         *
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*      *         *         *         *         *         *         *         *         *         *         *         *         *
*   2  *       0.* 3901598.* 3901598.*       0.* 6019888.* 6019888.*       0.* 1292227.* 1292227.*       0.* 3274968.* 3274968.*
*      *         *         *         *         *         *         *         *         *         *         *         *         *
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*      *         *         *         *         *         *         *         *         *         *         *         *         *
*   3  *  809547.*       0.*  809547.* 1864448.*       0.* 1864448.*       0.*       0.*       0.*  950668.*       0.*  950668.*
*      *         *         *         *         *         *         *         *         *         *         *         *         *
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*      *         *         *         *         *         *         *         *         *         *         *         *         *
* TOTAL* 4370570.* 4024622.* 8395192.* 3997462.* 6226444.*10223906.* 1828112.* 1292227.* 3120339.* 1253122.* 3340212.* 4593334.*
*      *         *         *         *         *         *         *         *         *         *         *         *         *
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            *                                                                                                        *
            *                                          FACILITY UTILIZATION                                          *
            *                                                                                                        *
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            *              *              *              *              *              *              *              *
            *   DUMPER 1   *   DUMPER 2   *  RECLAIM 1   *  RECLAIM 2   *   DOZER 1    *   DOZER 2    *  SHIPLOADER  *
            *              *              *              *              *              *              *              *
            **********************************************************************************************************
            * TIME *   %   * TIME *   %   * TIME *   %   * TIME *   %   * TIME *   %   * TIME *   %   * TIME *   %   *
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            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
  DOWN TIME *   0. *   0.0 *   0. *   0.0 *   0. *   0.0 *   0. *   0.0 *   0. *   0.0 *   0. *   0.0 *   0. *   0.0 *
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
            **********************************************************************************************************
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
  IDLE TIME *3823. *  66.4 *4519. *  78.5 *4987. *  86.6 *4628. *  80.3 *3706. *  64.3 *3907. *  67.8 *5166. *  89.7 *
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
            **********************************************************************************************************
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
ACTIVE TIME *1937. *  33.6 *1241. *  21.5 * 773. *  13.4 *1132. *  19.7 *2054. *  35.7 *1853. *  32.2 * 594. *  10.3 *
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
            **********************************************************************************************************
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
    USER  1 *1685. *  29.3 *  35. *   0.6 * 356. *   6.2 *  30. *   0.5 *1420. *  24.7 *  26. *   0.5 * 385. *   6.7 *
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
            **********************************************************************************************************
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
    USER  2 *   0. *   0.0 *1206. *  20.9 *   0. *   0.0 *1103. *  19.1 *   0. *   0.0 *1827. *  31.7 * 204. *   3.5 *
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
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            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
    USER  3 * 252. *   4.4 *   0. *   0.0 * 417. *   7.2 *   0. *   0.0 * 634. *  11.0 *   0. *   0.0 *   4. *   0.1 *
            *      *       *      *       *      *       *      *       *      *       *      *       *      *       *
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        *                                            FACILITY SUMMARY                                             *
        *                                          TRAIN QUEUING SYSTEM                                           *
        ***********************************************************************************************************
        *                                                    **                                                   *
        *               TRAIN RECEIVING QUEUE                **                 TRAIN EXITING QUEUE               *
        *                                                    **                                                   *
        ***********************************************************************************************************
        *          *         *         *         *         **          *         *         *         *         *
        * NUMBER OF * AVERAGE * MAXIMUM * AVERAGE * MAXIMUM ** NUMBER OF * AVERAGE * MAXIMUM * AVERAGE * MAXIMUM *
        *   TRAINS  *  QUEUE  *  QUEUE  *  QUEUE  *  QUEUE  **   TRAINS  *  QUEUE  *  QUEUE  *  QUEUE  *  QUEUE  *
        * PROCESSED * LENGTH  * LENGTH  *  TIME   *  TIME   ** PROCESSED * LENGTH  * LENGTH  *  TIME   *  TIME   *
        *           *         *         *  (HR)   *  (HR)   **           *         *         *  (HR)   *  (HR)   *
        ***********************************************************************************************************
        *           *         *         *         *         **           *         *         *         *         *
GENERAL *      609. *  0.003  *  1.000  *  0.028  *  4.490  **      609. *  0.000  *  1.000  *  0.002  *  0.290  *
        *           *         *         *         *         **           *         *         *         *         *
        ***********************************************************************************************************
        *           *         *         *         *         **           *         *         *         *         *
USER  1 *      228. *  0.001  *  1.000  *  0.022  *  3.750  **      228. *  0.000  *  1.000  *  0.003  *  0.289  *
        *           *         *         *         *         **           *         *         *         *         *
        ***********************************************************************************************************
        *           *         *         *         *         **           *         *         *         *         *
USER  2 *      347. *  0.000  *  1.000  *  0.007  *  0.700  **      347. *  0.000  *  1.000  *  0.002  *  0.290  *
        *           *         *         *         *         **           *         *         *         *         *
        ***********************************************************************************************************
        *           *         *         *         *         **           *         *         *         *         *
USER  3 *       34. *  0.002  *  1.000  *  0.285  *  4.490  **       34. *  0.0    *  1.000  *  0.0    *  0.0    *
        *           *         *         *         *         **           *         *         *         *         *
        ***********************************************************************************************************


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        *                                                                                                                                   *
        *                                                          FACILITY SUMMARY                                                         *
        *                                                 SHIP RECEIVING AND LOADING DATA                                                   *
        *                                                                                                                                   *
        *************************************************************************************************************************************
        *          *         *         *         *         *         *         *         *         *         *         *         *
        * NUMBER OF * AVERAGE * AVERAGE * MAXIMUM * MINIMUM * AVERAGE * MAXIMUM * MINIMUM * AVERAGE * MAXIMUM * AVERAGE * MAXIMUM *
        *   SHIPS   *  SHIP   * LOADING * LOADING * LOADING * LOADING * LOADING * LOADING *  QUEUE  *  QUEUE  *  QUEUE  *  QUEUE  *
        *  LOADED   * TONNAGE *  TIME   *  TIME   *  TIME   *  RATE   *  RATE   *  RATE   * LENGTH  * LENGTH  *  TIME   *  TIME   *
        *           *  (ST)   *  (HR)   *  (HR)   *  (HR)   * (ST/HR) * (ST/HR) * (ST/HR) *         *         *  (HR)   *  (HR)   *
        *************************************************************************************************************************************
        *           *         *         *         *         *         *         *         *         *         *         *         *
GENERAL *      349. * 28997.  *  5.457  * 15.203  *  2.858  *  5640.  *  6999.  *  1478.  *  0.092  *  3.000  *  1.518  * 20.383  *
        *           *         *         *         *         *         *         *         *         *         *         *         *
        *************************************************************************************************************************************
        *           *         *         *         *         *         *         *         *         *         *         *         *
USER  1 *       58. * 40000.  *  6.638  *  6.762  *  5.956  *  6030.  *  6714.  *  5916.  *  0.013  *  1.000  *  1.323  *  6.344  *
        *           *         *         *         *         *         *         *         *         *         *         *         *
        *************************************************************************************************************************************
        *           *         *         *         *         *         *         *         *         *         *         *         *
USER  2 *      199. * 29950.  *  5.541  * 15.203  *  2.858  *  5756.  *  6999.  *  2454.  *  0.057  *  2.000  *  1.649  * 20.383  *
        *           *         *         *         *         *         *         *         *         *         *         *         *
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        *           *         *         *         *         *         *         *         *         *         *         *         *
USER  3 *       92. * 20000.  *  4.533  * 13.531  *  3.336  *  5144.  *  5995.  *  1478.  *  0.022  *  1.000  *  1.358  *  9.320  *
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*                                                                                                                                    *
*                                                         FACILITY SUMMARY                                                           *
*                                          TRAIN UNLOADING AND STOCKPILING SYSTEM 1                                                  *
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*        *           *                          *                          *                         *                        *                      *
* USER   * TRAINS    *      ENTERING TIME       *      DUMPING TIME        *      DUMPING RATE       *      EXITING TIME      * TOTAL TIME ON PLOT   *
* NUMBER * PROCESSED *  AVE     MAX      MIN    *  AVE     MAX      MIN    *  AVE     MAX      MIN   *  AVE     MAX     MIN   *  AVE    MAX      MIN *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
*    1   *    216.   *  0.52    4.25     0.50   *  5.20    16.42    2.94   *  2325.   3400.   609.   *  0.50    0.79    0.50  *  6.22   17.42   3.94 *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
*    3   *     34.   *  0.78    4.99     0.50   *  3.01    3.08     2.95   *  3325.   3395.  3244.   *  0.50    0.50    0.50  *  4.29    8.45   3.95 *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
* TOTAL  *    250.   *  0.56    4.99     0.50   *  4.90    16.42    2.94   *  2461.   3400.   609.   *  0.50    0.79    0.50  *  5.96   17.42   3.94 *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
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**************************************************************************************************************************************
*                                                                                                                                    *
*                                                         FACILITY SUMMARY                                                           *
*                                          TRAIN UNLOADING AND STOCKPILING SYSTEM 2                                                  *
*                                                                                                                                    *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
* USER   * TRAINS    *      ENTERING TIME       *      DUMPING TIME        *      DUMPING RATE       *      EXITING TIME      * TOTAL TIME ON PLOT   *
* NUMBER * PROCESSED *  AVE     MAX      MIN    *  AVE     MAX      MIN    *  AVE     MAX      MIN   *  AVE     MAX     MIN   *  AVE    MAX      MIN *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
*    1   *     12.   *  0.60    0.60     0.60   *  2.93    2.98     2.88   *  3414.   3470.  3351.   *  0.40    0.40    0.40  *  3.93    3.98   3.88 *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
*    2   *    347.   *  0.61    1.30     0.60   *  3.49    8.08     3.14   *  3210.   3498.  1361.   *  0.40    0.69    0.40  *  4.50    9.16   4.14 *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
*        *           *                          *                          *                         *                        *                      *
* TOTAL  *    359.   *  0.61    1.30     0.60   *  3.47    8.08     2.88   *  3217.   3498.  1361.   *  0.40    0.69    0.40  *  4.48    9.16   3.88 *
*        *           *                          *                          *                         *                        *                      *
**************************************************************************************************************************************
```