SIMULATION STUDY OF AN AUTOMATED AIR CARGO TERMINAL

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ABSTRACT
SuperTerminal 1, the main terminal of Hong Kong Air Cargo Terminals Limited (Hactl) located at the south east corner of the Hong Kong International Airport, is a US$1 billion investment and it is the largest air cargo terminal of the busiest airport in the world. This 6-storey infrastructure consist a complex array of interconnected computer controlled material handling systems. This paper illustrates the use of simulation modeling as a planning tool for service improvement of this world-class automated air cargo terminal. The objective of the simulation is to substantiate the value of service improvement initiatives. The results from the simulation model were used to quantify and assess the impact before implementation of these service improvement initiatives. A simulation model of the existing operation was built and validated. Experiments were performed by transforming operational orders of typical days into input orders under assumptions of different "what-if" scenarios

Keywords: air cargo terminal, simulation, airport, material handling system

1. BACKGROUND

Hong Kong International Airport has been ranked as the busiest airport for international air cargo since 1996. In 2006, Hong Kong International Airport handled 3.6 million tonnes of freight in which 80 percent are handled by the Hong Kong Air Cargo Terminals Limited (Hactl). Hactl also serves over 90 airlines and 1,000 freight forwarders. At the heart of Hactl that handle the air cargos is the main terminal called SuperTerminal 1 (ST1) which basically is a giant 6-storey infrastructure consisting of interconnected automatic storage and retrieval systems, powered roller decks, automatic cargo hoists, transfer vehicles and other material handling systems centrally controlled by a computer system called Logistics Control System (LCS).

ST1 is a multi-storey automatic warehouse consists of 6 levels (Figure 1). Air cargos are loaded and unloaded at the truck docks located in the G/F and the 1/F. The second floor is a circulating conveyor system called the Unitized Cargo Distribution System (UCDS) for moving cargo units throughout the terminal. Workstations are located at the 3/F and the 4/F for cargo build-up and break-down. Empty containers are stored at the top level.

ST1 is divided into three key operational areas namely landside service area (Landside), bulk cargo service area (BCS), and airside service area (Airside). Landside is responsible for the cargo release and cargo acceptance to shippers, consignee, and transportation companies in accordance with the service instruction from Airlines, shippers, consignees or transportation companies. Landside is also responsible to the truck management in truck park and truck dock. BCS is responsible for the cargo break-down, build-up and consolidation in accordance with airline service instruction. Airside is responsible for the ULD transfer-in and transfer-out operation in accordance with stipulate service requirement. Airside is also responsible for the empty ULD management and overall CSS management for frontline.

The ST1 terminal capacity is over 3.5 million tones per annum and it operates with two giant cargo handling systems: the Container Storage System (CSS) and the Bulk Storage System (BSS). BSS is located in the middle of ST1. Air cargos, not containerized in unit load devices (ULD), are stored in BSS. In addition, there is also a system of automated guided vehicles (AGV), called the Bulk Cargo Distribution System (BCDS), located as ring structures around the entries and exits of BSS. The BCDS is tightly integrated to the BSS to handle import and export air cargos moving in and out of the BSS. Besides, loaded and empty ULDs are handled in CSS. The main focus of this paper is on the simulation study of the CSS.

Located on both the east and west wings of the ST1, CSS is a cargo handling facility offering storage of ULDs and circulating them across the terminal. CSS consists of 12 computer controlled automatic stacker cranes (SC) which service a matrix of compartment spaces with more than 3,500 storage locations that are divided into 12 zones. These zones are located in two wings (east and west wings). Each wing has 4 sets of conveyors behind the outer CSS compartment served as by-pass links to connect CSS zones of the same wing. The east and west wings are separated by the BSS, the

Landside and the BCS. Landside is located on the G/F and 1/F. There are about 200 truck docks in the Landside for cargos acceptance or release. BCS is located on the 3/F and 4/F where over 300 workstations are installed. The workstations are ULD holding places for cargo build-up and break-down. The CSS is connected to the workstations by 72 link bridges with 40 Automated Transfer Vehicles (ATV) as the interfacing equipment. There is also a network of interconnecting conveyors, hoists and transfer vehicles that connect all 12 zones together. The UCDS is the main conveyor structure that connect the east and west wings. Altogether, there are 24 cargo hoists (CH) located in east and west wings for transferring ULDs vertically across the CSS including 14 building hoists located near the center structure of ST1 and 10 CSS inner hoists located between the ULD storage compartments. There are also 4 CHs in the north wing for transporting perishable cargo units. Moreover, there are over 140 System Entry / Exit Points (SEP) located at different locations for direct man-machine interface for ULD storage, transfer and retrieval.

In order to assess the performance of various activities, processes, resources and equipment in ST1, the simulation team of the Industrial and Manufacturing Systems (IMSE) department of the University of Hong Kong (HKU) was commissioned by Hactl to undergo a simulation study on the CSS of ST1. The result of the study had been successfully delivered to Hactl in mid-2007. This paper describes how the simulation model can be used to help Hactl in substantiating the value of service improvement initiatives and quantifying the impacts under different “what-if” scenarios.

The use of simulation in facility planning and process improvement is not new to Hactl. Luk (1990) explained how Hactl use simulation to evaluate system features before final design and construction prior to the relocation of the Hong Kong International Airport from Kai Tak to Chap Lap Kok in 1998. Since ST1 of Hactl is such a complex and highly automated structure, ST1 has been a subject of a number of researches. Lau and Zhao (2006) used ST1 as a typical case in the development of an integrated scheduling methodology for automated cargo handling system. On (2005) proposed a dynamic routing strategy for automatic material handling system and the strategy was benchmarked with the existing routing strategy of ST1 using simulation. In general, because of the complexity of air cargo handling processes and the keen competition between airports, simulation is found to be a valuable tool to maximize performance and push down costs in real life applications. DeLorme et al. (1992) illustrated the use of simulation for evaluation and analysis of air cargo operations by describing the development of a simulation model for the Dallas/Fort Worth Airport cargo hub of AA Cargo. Nsakanda et al. (2004) used simulation to quantitatively evaluate and compare different policies, business practices and processes within a given set of operational and business constraints before the new facility was put into operation.

This paper is organized as follows: a brief description of the air cargos handling in Hong Kong is described in section 2. The simulation model is discussed in section 3. Results and analysis are reported in section 4. At the end of this paper, the conclusion of the simulation study is presented.

2. OVERVIEW OF OPERATION IN HACTL

In general, the service operations in Hactl can be classified into three major types in all export, transshipment and import flow cycles. These operations are: prepacked cargo handling, bulk cargo handling and perishable cargo handling.

2.1. Export Flow

Figure 2 shows the flow processes in export cargo handling.

2.1.1. Step 1: Cargo Acceptance

Prepacked cargos are accepted at different locations. At the ground floor of ST1, acceptance of prepacked cargo is performed on the Prepacked Cargo Handling Centers and the Perishable Cargo Handling Centers. Prepacked cargo can also be accepted at the Twenty-foot ULD Storage Center and the Hactl ULD Center located at the southern end of the Express Center and the northern end of the East Truck Park respectively.

The acceptance of bulk cargos are performed on both ground floor and first floor of ST1. After cargo acceptance on first floor, the bulk cargos are stored into BSS. For bulk cargo accepted on ground floor, the bulk cargos are stowed into the CSS.

Export perishable cargos are accepted at the Perishable Cargo Handling Center located at the north wing of ST1 and on both G/F and 1/F, with direct interface with the Airside.

2.1.2. Step 2: Cargo Processing

After cargo acceptance, prepacked cargos will be moved through powered roller decks, cargo hoists, ATVs and SCs and then stored in CSS prior to outbound dispatch.

Loose bulk cargos will be loaded onto boxes/bins at the time of acceptance. Loaded boxes/bins will be moved into the BCDS. The loaded boxes/bins will then be stored in BSS through the BCDS. According to each pre-manifest from an airline, related bulk shipments are retrieved from BSS and the cargos are built up with appropriate ULDs on the workstation floors. After cargo build-up, cargo units are then transferred to CSS for temporary storage or directly transported to Airside for immediate outbound dispatch

Perishable cargo will be directly transferred to the cool room after acceptance for temporary storage or immediately outbound dispatched to Airside.

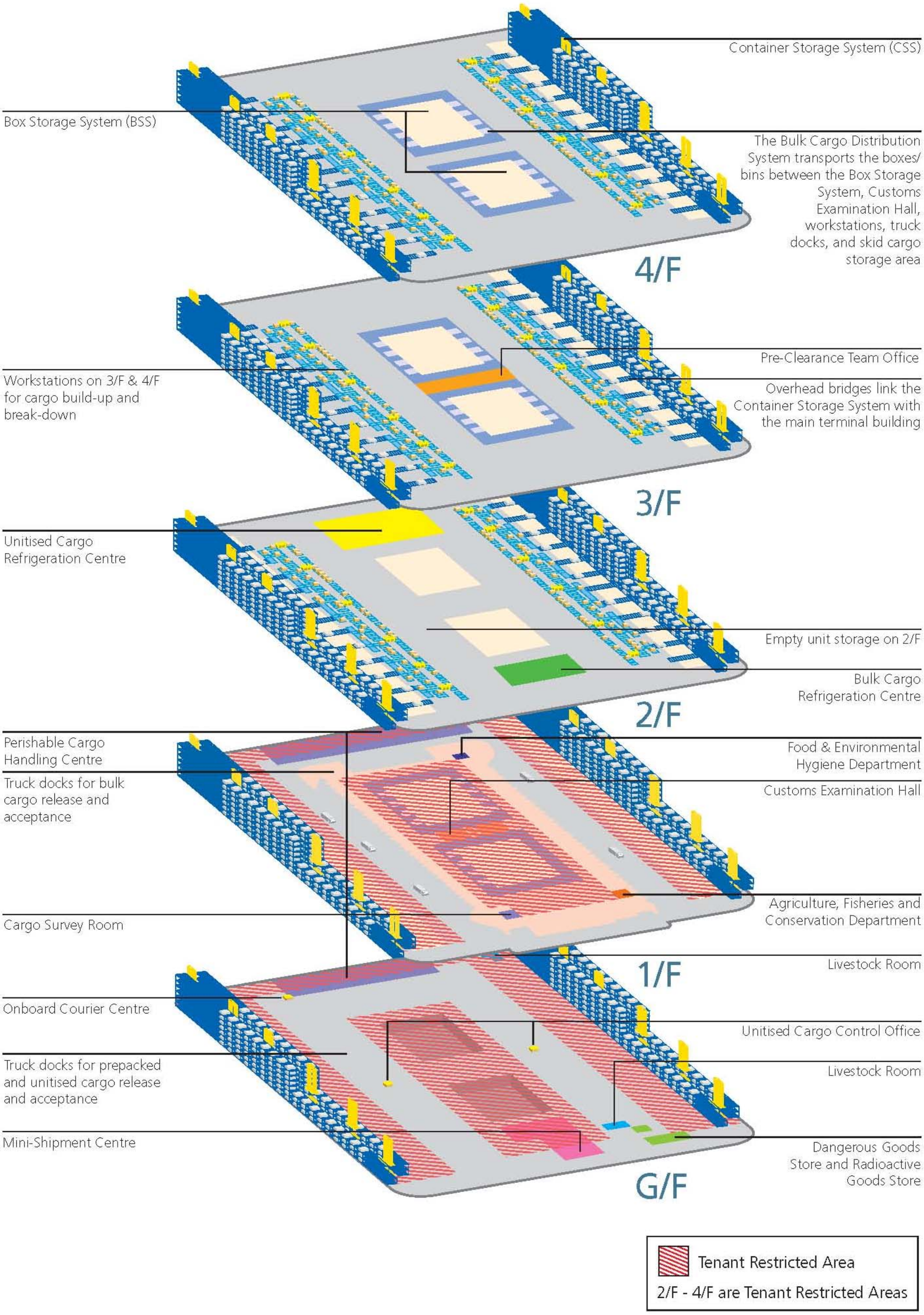

Figure 1 ST1's Cargo Handling Area (Hactl, 2007)

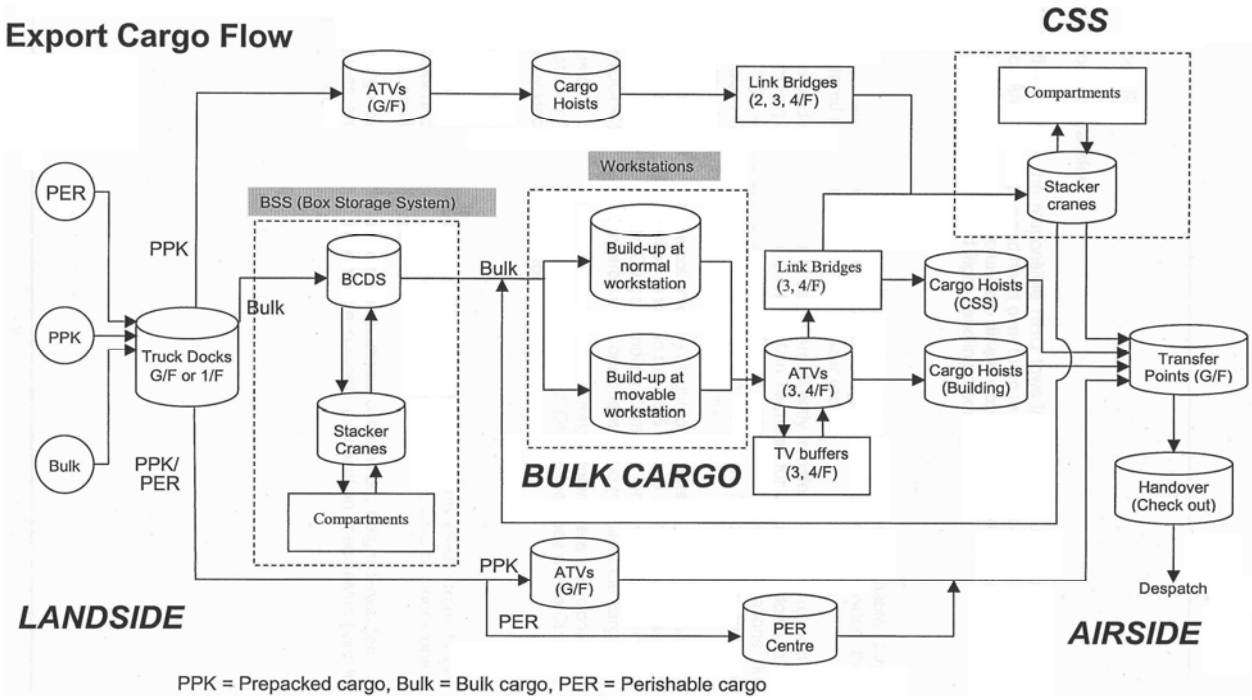

Figure 2: Export Cargo Flow (Source: Hactl)

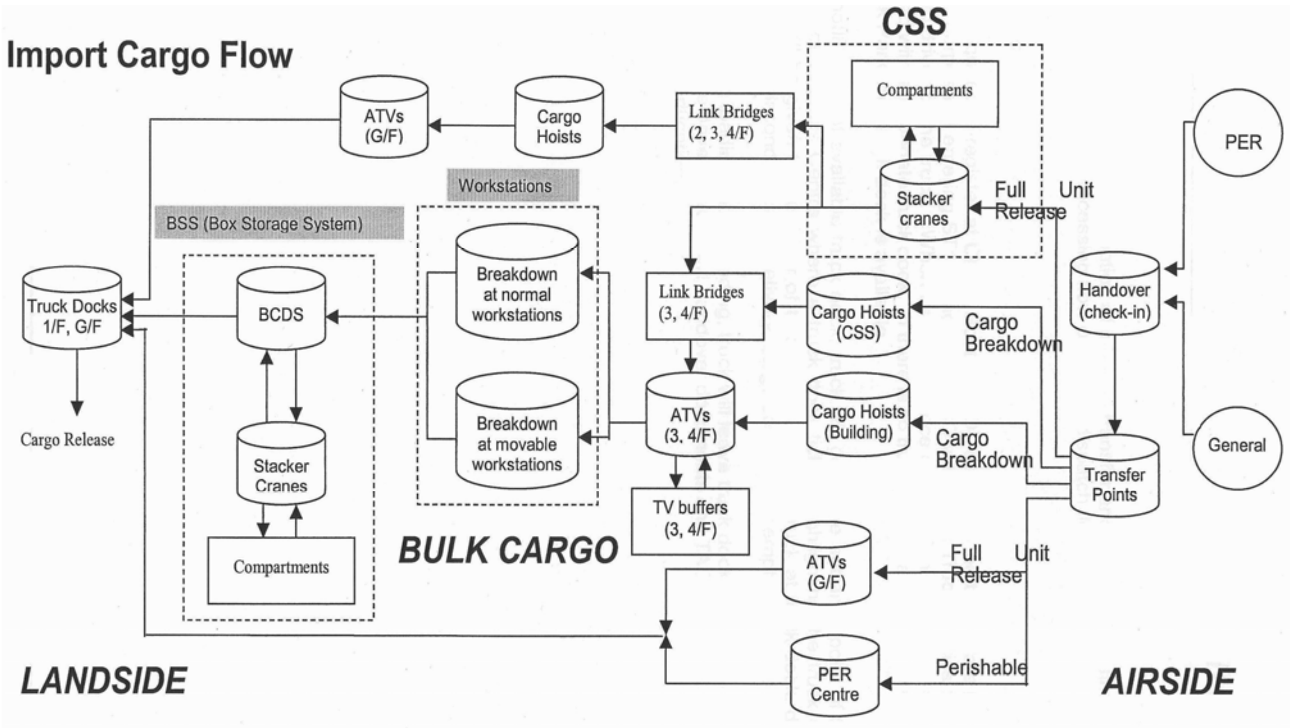

Figure 3: Import Cargo Flow (Source: Hactl)

2.1.3. Step 3: Outbound Dispatch

All export cargos are transported to the Airside Interface Area some time before the Scheduled Times of Departure (STD) of their respective export flights assigned to them according to the pre-agreed airside service standards. The cargo units are then picked up at the CSS outbound transfer points and towed on-dolly to the dolly staging lanes by the Airside staff. Thereafter, the export cargos are handed over to the responsible Ramp Handling Operator (RHO) to complete the outbound dispatch process.

2.2. Import Flow

Figure 3 shows the flow processes in import cargo handling

2.2.1. Step 1: Inbound Transfer

Upon flight arrival, the responsible RHO tows import cargo units to the Airside Interface Area for staging and hand over them to Hactl. These inbound cargo units are then transported to different operational areas according to their respective cargo natures and flight handling modules.

2.2.2. Step 2: Cargo Processing

For perishable cargo, they are released to consignees at the Perishable Cargo Handling Center immediately after cargo handover with RHOs. Otherwise, they will be stored inside the cool room.

Containerized / palletized general cargos are directly transferred to their respective flight handling modules (3/F and 4/F of ST1) for cargo breakdown. After the breakdown process, cargos will be stored in BSS, or appropriate storage locations like Refrigeration Center, Dangerous Goods (DG) room, Live Stock Room, and floor goods area, depending on their cargo nature.

For those general cargos to be collected by freight forwarders or consignees in a full unit or unitized form, they will be stored in the CSS prior to cargo release, and are transported to the Prepacked Cargo Handling Center or Unitized Cargo Handling Center (UCHC) when the forwarders or consignees come to collect the cargo.

2.2.3. Step 3: Cargo Release

Upon receipt of duly authorized Shipment Release Form for freight forwarders or consignees, cargo will be retrieved from BSS, CSS or other storage locations and handled over to them.

If the cargo being collected remains customs constrained, freight forwarders or consignees are required to complete customs examination themselves prior to leaving the terminal.

2.3. Transshipment Flow

Transshipment flow is a combination of flow processes. It combines the inbound transfer and cargo processing of the Import Flow with cargo processing flow outbound dispatch flow in Export Flow

3. THE SIMULATION MODEL

3.1. Key factors to success

There are a number of factors that constitute the success of a simulation project (Shannon, 1998.). In this particular project described in this paper, there are three key conditions needed to be satisfied before starting the construction of the simulation model of such a complex structure. Fulfilling these conditions is the major reason contributing to the success of the project.

The first condition is the readiness of data. Since the ST1 operation is highly computerized, all cargo handling activities in the ST1 are logged automatically. The availability of sufficient amount of accurate and relevant data reduces a lot of uncertainty in model building.

Secondly, the simulation team members' understanding on the ST1 cargo handling processes is also of vital importance to the success of the project. The more the team members know about the operation of the system, the better the model will be built. Since the IMSE department of HKU values highly on the connections with the logistics industry in Hong Kong, an informal relationship has been built up between the simulation team and Hactl even before Hactl's request of the simulation study. The relationship is developed through study tours, informal visits and trial studies. Thus, the simulation team has already had some preliminary knowledge on ST1's operational processes beforehand.

Most importantly, the simulation project is supported by Hactl's management. The management realizes the benefits of simulation study and the value of alternative source of information for decision making before a major investment on service improvement or new facilities. Through meetings, demonstrations of past experiences of the simulation team and the teams' expatiation on their understanding on ST1's operation, confidence and trust on the team has been developed. The support of Hactl's management greatly facilitates the communication of all parties and personnel involved in this project.

3.2. Model Development

The development of the simulation model mainly follows the procedures described in "the steps in a simulation study" of Banks and Carson (2001). Before the project formally started, objective of the simulation was clarified and the boundary, scope and level of details of the model were defined through meetings with all related parties. A formal proposal was submitted to the management of Hactl for approval. The proposal included the objective of the study, a detail planning and development schedule of the project, project cost, assumptions made in the model, well defined model boundary, scope and level of details, expected output from the model and the information required in building and running the model such as historical data, schematics, process diagrams, control logics of conveyors, AGV, cargo hoists,…etc.. A simplified model prototype had also been built to demonstrate the user interface of input data, the visualization control of the model animation and the graphical presentation of the resulting simulation output data.

After the proposal was accepted, a simulation team was formally formed. The simulation team included a project manager whose main responsibility was to oversee the progress of the project and coordinate the team members in the course of model development. There was also a representative from Hactl in the team to collect all information from Hactl. He also arranged on-site visits or interviews with Hactl's operation staff for the simulation team. Feedback from the representative was also important to ensure the project was moving in a direction align with the management expectation in the progress of the project. Besides, there were altogether four analysts who cooperate within themselves to perform model design, model building, data modeling, programming, verification, validation and scenario analyses.

3.3. Objective, boundary and scope

The objective of the simulation is to study the throughput, utilization and cycle time of the processes, resources and equipment of the CSS. In CSS, either loaded or empty ULDs or unitized general cargo units are processed. Individual air cargos will not be handled. Thus, the smallest unit of entity under this study is defined to be the containers but not the individual cargos.

The boundary of the system can be clearly defined by the SEPs. ULDs are moved into the system or moved out from the system through any one of these SEPs. The SEPs are the interface between the CSS and the airside / landside. ULDs moving into the CSS from airside / landside or moving out to the airside / landside must pass through one of the SEPs. Within CSS, ULDs are either transporting on a material handling facility, such as a powered roller decks or a cargo hoist, or stored on a TV buffer or in a compartment storage location.

3.4. Model Conceptualization

Simulation modeling is both a science and an art (Shannon, 1998) and the essence of the art of modeling is abstraction and simplification. Including too much details of this complex system into the model makes the model not only too inefficient to run but also too expensive to build. It may take a longer time to construct the model and may not be able to deliver the necessary information to the management before the dead line. On the contrary, oversimplified model may have too many assumptions which may not of value to the decision making of the management. The challenges are to identify the essential parts of the problem, choose the right level of details and design the model around the problem accordingly.

The main theme of the study is to analyze the traffic of the CSS which is basically a huge material handling system. Thus, choosing a commercially available simulation software package that is efficient in modeling material handling system is important. Moreover, the traffic of the CSS can be viewed as the aggregation of movement of containers or unitized cargos moving through the system. Thus, the major input to the model should be the generation of transportation orders of the ULDs in the system. However, as described in later part of this section, ULDs can be originated from a large number of locations and they can also have a large number of destination. There are a large number of source / destination combinations and there are also a great number of routes that a ULD can move through. In designing the model, it is important to implement all the routes into the system without getting lost in the complexity.

The Pareto principle, which is also known as the 80-20 rule, states that, for many events, 80% of the effects come from only 20% of the causes. After analyzing the historical data of the CSS, it is found that the 80-20 rule is also true in the traffic of CSS. Thus, different routes with different source / destination combinations are classified into different priorities and the modeling effort is also allocated to different routes accordingly.

The processes to transport a ULD within the CSS, no matter it is an import, export or transshipment flow, can be categorized into four different order types namely storage, transfer, retrieval and reshuffling. Storage and retrieval orders are instructions for ULD storage into compartment and retrieval from compartment respectively. Transfer orders are instructions for sending ULD from one location to another location within the CSS structure outside the compartment storage locations. Reshuffle orders are instructions for sending ULD from one compartment to another compartment. Depending on the size of the ULDs, more than one ULD can be placed in a single compartment storage location. Therefore, a reshuffle order must be issued to relocate the front ULD before the ULD at the back of the same storage location can be retrieved. Although reshuffle orders are non-productive and should be minimized, this type of orders can be hardly avoided especially when the utilization of compartment is high.

Since Hactl is a highly automated material handling system, all issued orders are recorded by the LCS. These recorded orders represent faithfully the operational activities happened in the entire CSS. Therefore, the model is designed with its input similar to the format of an order file and generates loads based on the information of an order. There is an advantage in validation to design the input in this way. Since the order file for each day is readily available, only minor modification and conversion is needed before feeding into the model. Days of order files can be cascaded together to form a single input file and the resulting behavior of the model can be used for comparison of the log files.

The complexity of the model mainly comes from the vast diversity of the routes traveled for different source / destination combination of the ULD transportation orders. The CSS contains altogether 14 zones, 6 for the east wing, 6 for the west wing and 2 for the north wing. Zones in the east or west wings are subdivided into 9 areas namely Landside (G/F), BCS (3/F), BCS (4/F), Airside (Building), Airside (Inner), Airside (Outer), 2/F, Compartment and Roof Top. Zones in the north wing are subdivided into 8 areas: PCHGK, PCHGU, PCH1K, PCH1U, airside, 2/F, BCS (3/F) and BCS (4/F). Orders can be generated from any area / zone as the source and any other area / zone as its destination. Each area contains a number of end units: workstations, TV buffers, compartment or SEPs. If individual locations are grouped into their corresponding areas, there are approximately (6x9x2+2x8)*(6x9x2+2x8) = 15376 different source / destination combinations. Furthermore, each source and destination combination may have more than one route. Also, there are about 2500 decision points scattered on the paths of different routes. When a ULD arrives at a decision point, the program in the model should be able to instruct the ULD to choose the correct branch based on its destination and other relevant conditions at the moment of the ULD arrival.

To tackle the complexity of the system, routing tables are used. These routing tables are designed to specify all the routing conditions at a decision point. After designing the control mechanism of the routing tables, simulation analysts can work separately in parallel to fill in the routing tables. Programmers can also focus on writing efficient algorithms to decode the routing tables and table look-up for the routing decisions. With the use of routing tables, the implementation of routing decision can be separated from coding. Also, routing decisions of different zone or area can be handled by different analysts. More workforces can then be put into the simulation team to shorten the duration of model development.

Since the CSS is centrally controlled by the LCS computer system, one way to implement the decision rules in the routing tables is to refer directly to the routing rules that have been programmed in the LCS. This approach requires an updated program documentation of the LCS. Reading program documentation is helpful for the simulation analysts to understand the system but relying on the documentation to build the simulation model is risky since the documentation may not be fully updated. The simulation analysts also needed to be granted the right to read the source codes of the LCS control program. However, this approach is not feasible simply because it is too inefficient to understand a program of such a large system by tracing the logics of the source codes written by somebody else.

Another way to determine the decision rules in the routing tables is to draw inferences of routing rules from the observation of ULD movements recorded in the log files and ignore what has been programmed in the LCS. In CSS, whenever an ULD moved into a device, such as a power roller deck or a cargo hoist, the information of the activity will be generated. The information includes the date and the time, the ULD identity number, the device's identity number …etc. The information are recorded, collected and stored in a daily log file. These daily log files faithfully record what has happened in the CSS. Simulation analysts analyze the log files and implement routing rules from observation on the log files without knowing how the LCS controlling the system in detail.

Although there are a large number of source / destination combinations of the ULD transportation orders, not all combinations have the same amount of traffic. It is found that the majority of the traffic is within the same zone and between two adjacent zones. These two types of traffic formed the highest portions in the whole CSS up to about 84% (Figure 4).

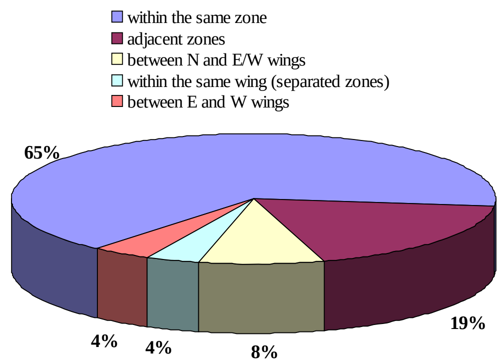

Figure 4: Traffic between different locations in CSS

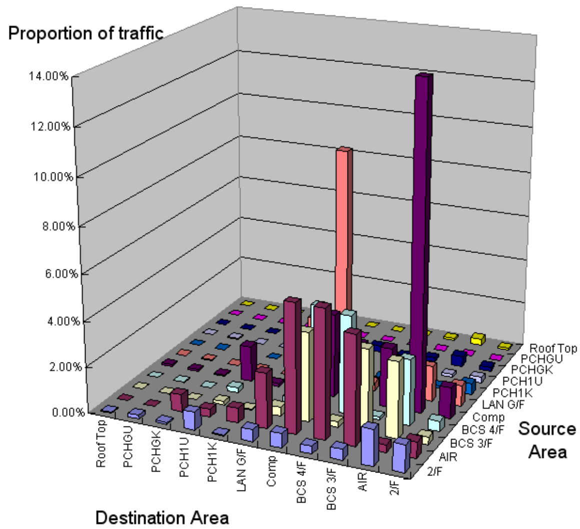

Figure 5: Source/Destination Analysis

After investigating the log files, it is obvious that the simulation analysts should put more effort in the traffic within the same zone and the traffic between adjacent zones because these paths have the greatest traffic and hence have the largest impact to the system.

Traffic between the North and the East or West wings is the second priority. Then, the traffic within the same wing but between separated zones is the next. Although the East and the West wings had the largest number of source / destination combinations, ULD movements between these two wings had the least traffic. Thus, this should be the last one to be handled.

A better understanding of the traffic in CSS can be reviewed if further analyses into the area level. A sample source /destination analysis of a typical day is shown on Figure 5.

From these analyses, it is found that the highest traffic is the traffic from compartments to the airside and the traffic from the landside ground floor area to the compartments. The majority of the rest of the traffic is the traffic among the compartments, airside and the BCS on 3/F and 4/F.

Apparently, the traffic inside the CSS obeys the Pareto principle. Simulation analysts should focus on the major ULD transportation paths which constitute relatively smaller portions of the total possible paths but with the greatest impacts on the traffic of the system. Analysts should also set a priority of their focus on the rest of the paths according to the amount of traffic of the path shown from the analyses. It does not mean that paths with less traffic can be implemented with less accuracy. In fact, an accurate model depends on whether all paths have been implemented accurately. The advantage of this approach is to keep the analysts alert to which source / destination combinations of ULD movements have the greatest impact on the overall traffic of the system. Setting the implementation priority of the paths can facilitate the credibility on the model to be built up more quickly because there is a higher chance to show to the people involved that an 80% correct model can be constructed within only 20% development time according to the 80-20 rule.

3.5. Data Collection

As the ST1 is highly computerized, activities in the system are automatically recorded as log files. There is no shortage of data. An advantage of using automatically logged data is that the chance of human error is comparatively small. Even though the chance of error is not high, the received data from Hactl is always examined before it is used in the model. Since there is a lot of data available, data need to be carefully selected and filtered so as to reduce redundancy and to extract information from the data to the right level of data abstraction. Furthermore, filtering out unnecessary data reduces the total amount of data processed in the computer and, reduces the amount of i/o handling and hence lowers the amount of memory required, and thus, increases the speed of model running. The primary input to the model is the ULD transportation orders. For each order, only the order initialization time, ULD identification number, order type, source location and destination location in terms of area and zone are needed.

Besides the input ULD transportation orders which can be found in the log files, some parameters in the simulation model, for example, processes involve human handling, needed to be modeled as statistical distributions estimated from historical data. These processes include the times for building up or breaking down a certain type of container and the engagement times of ULDs when it is transferred into the system or out from the system at a SEP. Some parameters, for examples, the speeds of the conveyors, SCs, CHs and ATVs, are taken from the operation specifications and carefully verified with logged data of ULDs passing through these equipments.

3.6. Model Translation

The model was built using Applied Material's AutoMod. Microsoft Excel 2003 programmed with VB scripts was used as the user interface. The whole system was running in Window XP on a workstation with Dual Core 3.2GHz CPUs and 4G RAM. A single run simulating one typical day operation could be completed within 10 minutes.

Statistics are collected at every 1 hour time slot. The output statistics are presented in Excel file in chart and data format. Collected statistics includes the statistic of all kinds of equipment - Automatic Transfer Vehicles, Bypass Lane, Compartment, Link Bridge, Stacker Crane, Transfer Point, Transfer Vehicle Buffer, UCDS, and Workstation. The utilization, throughput and cycle time of these equipments are recorded and shown on an excel interface. Statistic can be displayed at various levels - for individual equipment or average value in different grouping, e.g., by level, by zone, by wing, or by the direction of container movement.

3.7. Verification and Validation

To avoid preconceived understanding of an analyst on a path in the system, another analyst that is not involved in the determination of the routing tables or the program codes of the path is involved in the verification. Artificially made order files for testing of particular paths are created for model verification. Animation is used to allow the analysts to observe how a container moving through the system. Using this technique, most of the mistakes can be discovered.

Animation is also a good tool for validation. After model construction and verification, the model is validated with the assistance of the operation experts from Hactl. With the help of animation, operation experts can easily point out the difference from the real system. For example, at the junctions of conveyors crossing each others in different directions where the traffic is heavy, there are some special handling and control rules which are overlooked at the early stage of model development. Operation experts can point out the different directly on the animation simply because the animation looks different from their daily experiences.

Historical data are also used for comparison with the model output in the validation process. Altogether, 18 days data are used. These data can be separated into two groups. Each group of data is data from consecutive days of at least one week. The two groups are separated by more than a months. There is no exceptional event happens in any one of these selected days, i.e., these days can represent operation of typical days. The aim of validation of a model is to determine whether the model is an accurate representation of the system for the simulation purpose, i.e., the analysis of the traffic in the system. Thus, throughputs of three most critical types of equipment (stacker cranes, cargo hoists and automatic transfer vehicles) are chosen for the comparison. Paired t-test with the level of significance be $\alpha = 0.05$ together with correlation coefficient are calculated for the comparison.

4. USE OF THE SIMULATION MODEL

The reason to build a simulation model for the CSS is to quantify the impact of service improvement initiatives. There are a number of questions that the management would like to get the answers from the model: What happen if some workloads, says all workloads from the workstations of zone D or all workloads to compartment of zone L are suspended for a certain period of time? What is the impact if some equipment or SEP is out of service? Will the operation be resumed to normal after fixing the equipment? Is it possible to maintain the service by temporarily transferring the workloads from one group of SEPs to another group of SEPs for a certain period of time in case there are equipment failures? What are the differences of the impacts if the above situation happens at different times of a day?

All these questions are related to the traffic inside the system or, more precisely, the throughputs, utilizations and cycle times of all equipment in the system. To find out the impacts on different scenarios, historical data files are analyzed and modeled statistically into an input order file that represents typical operation days. This model with typical operation days input order file is referred to be the base scenario. Experiments can be done by feeding input order files which are obtained by transforming the input order file of the base scenario according to the assumptions of different “what-if” scenarios. The result of the experiments will then be compared with the result of the base scenario.

5. CONCLUSION

In this paper, the use of simulation for service improvement of the largest air cargo terminal in Hong Kong Airport has been illustrated and the approach of the simulation modeling is described.

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