Chapter 4

GROUND SUPPORT SYSTEMS

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There is a widely held point of view in the industry that air cargo's competition for increased volume and market share could be decided more by how well it performs on the ground than in the air. The ground side support systems so important to the future of air cargo include: 1) airport terminal operations, and 2) pickup and delivery services. Cargo must be picked up at the origin of the trip (usually by truck) and delivered to the airport. At the terminal cargo must be transferred from truck to aircraft, aircraft to aircraft, or from aircraft to truck. Cargo is offloaded, weighed if necessary, and sorted by destination. The necessary airbills and other pertinent forms move with the shipment.

Average terminal costs for processing bulk cargo, as a percentage of total line haul plus terminal costs, have been computed to vary from a high of *83* percent for flight lengths of *400* miles to 33 percent for a stage length of *4,000* miles.[1] The high percentage cost of ground operations for shorter trips is particularly significant, since it is in these domestic trips where air cargo confronts some of its strongest competition from surface modes.

[1]McDonnell Douglas Corp., Douglas Aircraft Co., *Cargo Logistics Airlift Systems Study (CLASS), Volume I: Analysis of the Current Air Cargo System*, prepared by R. D. Burby and W. H. Kuhlman, under NASA contract No. NAS1-14948 (Hampton, Va.: Langley Research Center, National Aeronautics and Space Administration, October 1978), p. 210. (Hereafter cited as "Douglas, *CLASS*.")

AIR TERMINAL SPACE LIMITATIONS

Several of the major air cargo terminals are approaching the limits of their capacity with current operations and equipment, thus creating a major problem for air cargo carriers.[2] It would be difficult to expand many of these terminals, given the lack of available land. Two options suggested to accommodate future increases in air freight traffic are: 1) off site bulk freight processing, and 2) all-cargo airports.[3]

Offsite bulk freight processing terminals move the freight consolidation operations away from the crowded airport areas, to less crowded, less expensive quarters. Consolidated freight could be moved back to the airport in containers or special bins. The airport area could be used for aircraft loading and a limited amount of container storage and staging functions. Terminal productivity would increase because of the greater use of containers, and congestion would decrease because trucks and parcels would go to the off site terminals.

While some forwarders and all-cargo carriers favor this option, combination carriers generally consider their passenger and freight operations to be too closely integrated to have separate terminals. These combination carriers believe they would need to duplicate some of their functions, equipment, and personnel.

The off site bulk freight processing terminal is of interest if there is a significant percentage of cargo not containerized by the shipper. The facility could be used by the forwarder or the airline to containerize cargo prior to the airport terminal operation.

The *all-cargo airport* would, as the name implies, be entirely devoted to the handling of cargo. Given the difficulty of developing any major new airports, this must be regarded as only a remote possibility. The Airport and Airways Development and Revenue Act of 1970

[2]Nawal K. Taneja, The *U. S. Air-freight Industry* (Lexington, Mass.: Lexington Books, 1979), p. 206.
[3]Ibid., p. 212.

made funds available for construction of new airports, but of the 85 new airports built during the first 5 years, all but three were for the use of general aviation exclusively.[4] Citizen opposition to major new airports continues to be a very potent and effective force.

It might be possible to use abandoned or underutilized military airports as all-cargo airports. The National Aeronautics and Space Administration (NASA) and the Air Force experimented with this idea at one Air Force base that was still in use but underutilized. The experiment was not successful because the demands of the Air Force mission compromised the kinds of services to the commercial tenants which the management of a commercial airport could provide.[5]

[4]Jeff Cochran, Associate Administrator for Engineering and Development, Federal Aviation Administration, presentation before the National Academy of Sciences.

‘Operations Research, Inc., *Joint Tenancy for Cargo Airports*, prepared by M. N. McDermott, under NASA contract No. NASW-2961 (Washington, D. C.: ORI, July 1977).

MECHANIZATION AND CONTAINERIZATION

One promising long-range option for alleviating the space problem at air terminals is mechanization. A major concern of terminal managers is to define the appropriate type of mechanization and the optimum rate at which it should be introduced into the cargo handling system. The desirable degree of mechanization depends on the volume of cargo, the degree of unitization (e. g., palletization or containerization) and the uniformity of shipments with respect to volume, shape, and weight. Today only a handful of heavily utilized terminals have either the volume or the size and type of shipments to warrant extensive mechanization.

Sorting of shipments is still done manually at most terminals, partly because of the large variation in package size. To reduce labor cost and save space, a number of carriers have automated these cargo handling functions at the major hubs. The success of this automation has been mixed. In the late 1960’s, TWA automated its cargo facilities in St. Louis airport so extensively that a failure in one component usually tied up the whole system, and there was also no room to make repairs. On the other hand, a number of European carriers have extensively automated their air freight operations with apparent success, although actual sorting decisions are still made by a human operator.

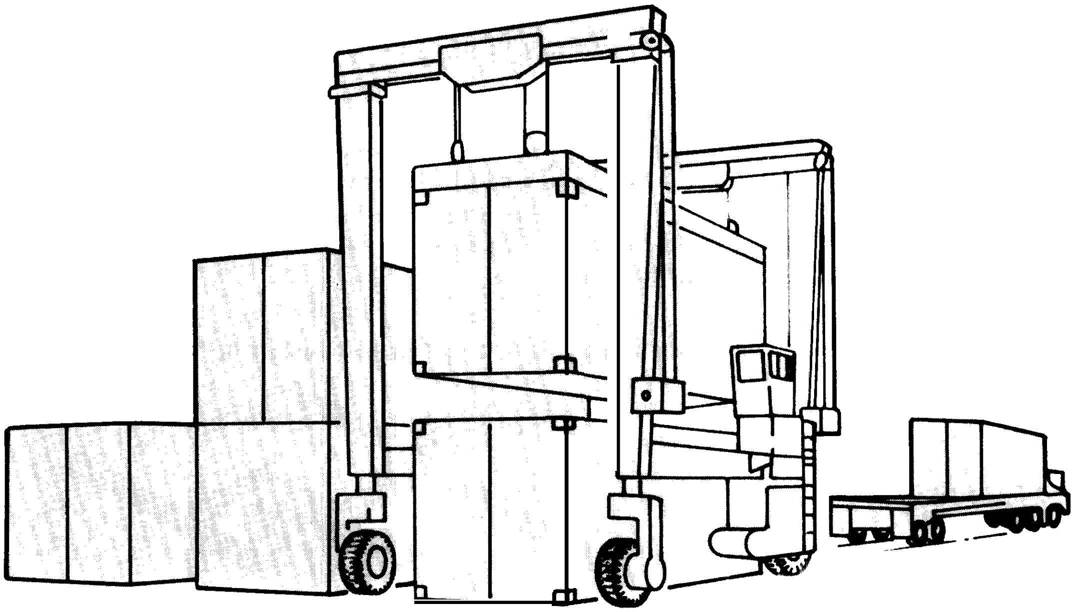
Varying degrees of mechanization are appropriate dependent on shipments. At the lower end of the spectrum, there are specially adapted forklifts for handling containers. There are also straddle lifts, illustrated in figure 4. Figure **5** shows two such containers stowed in a 747. Other mobile systems are commonly used for loading freight on aircraft. Such mobile equipment is less costly, and more cost effective for lower cargo volumes than is a fixed system.

As the volume and degree of unitization increases, the cost effectiveness of fixed mechanized systems, both for sorting and for loading, increases. Assuming an annual air cargo growth rate of 8 percent, an increasing number of systems are likely to become heavily mechanized in the future.[6] A NASA CLASS study forecasts that growth will initially be handled by increasing the efficiency of existing systems along with increased use of containers loaded by the shipper or forwarder. For example, with a modest investment, the equipment now widely used in terminals to handle large containers can be readily adapted to handle 3-meter containers and smaller. This could allow for over a fourfold increase in terminal throughput, with a resulting potential reduction in capital investment per container of 72 percent. To handle the popular 6-meter containers, a relatively advanced terminal capable of a ninefold increase over current processing levels could be achieved with currently available technology.[G]

One particularly useful technology for high volume situations is the elevating transfer vehicle (ETV) and stacker system which allows

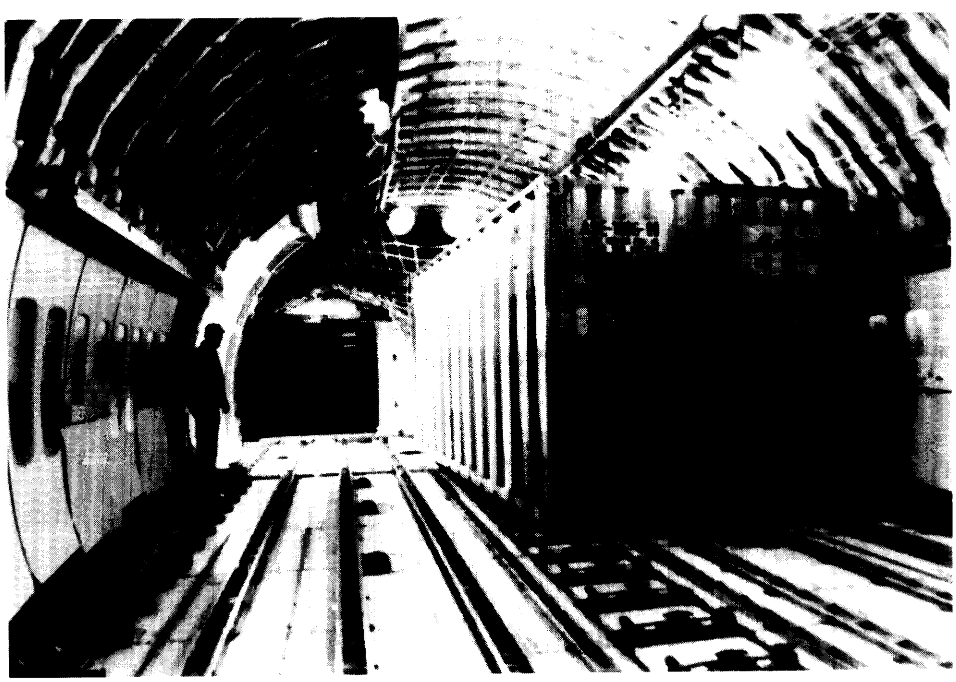
[6]Douglas, *CLASS, Volume III: Cross Impact Between the 1990 Market and the Air Physical Distribution System Book 1*, p. 180.

Figure 4.—Straddle Lift for 6. Meter or Large Col~[41]aliler



SOURCE McDonnell Douglas Corporation, Douglas Aircraft Company, Cargo logistics Airlift Systems 5 t‹m›S'‹, ‹. . volume II prepared by R D Bu rby and W H Kuhlman, under NASA contract 1-14948 (Hampton Va. Langley Research Center, National ı ti Space Admin istratı‹n October 1978) p18?

Figure 5.–Side-By-Side Loading Capability of Intermodel Containers in the B-747F



SOURCES: Nawal K. Taneja The u S , rfreightIndustry. (Lexington Mass ıexıngtıı Boo 9 '9) , 192
Seaboard World Airlines

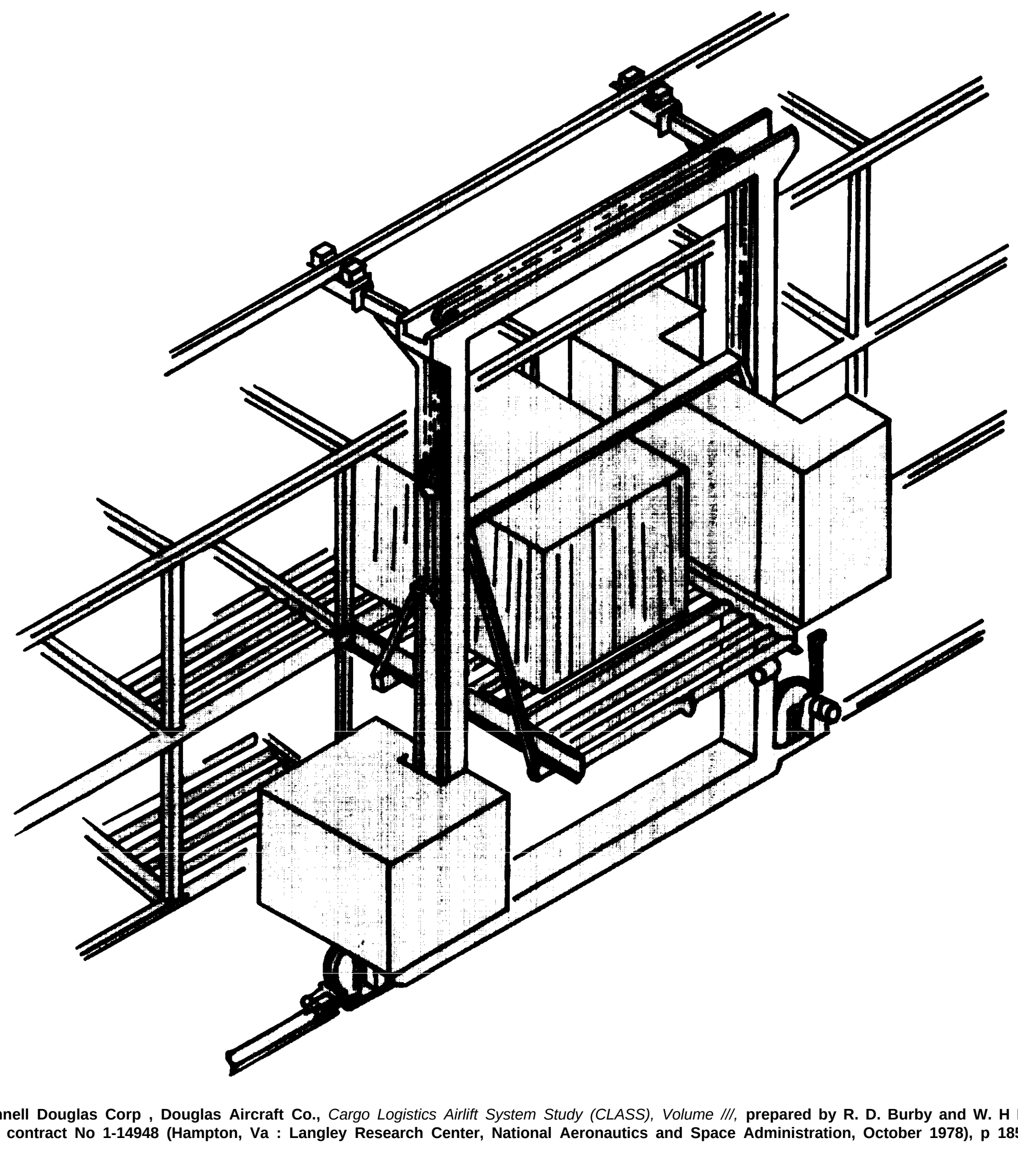
multilevel storage of containers where vertical space is not a restriction (see fig. *6).* Container weight reduces the useful payload of the aircraft, however, and there is a tradeoff between container strength—needed for stacking—and the extra weight required to achieve stacking strength.

Degree of Mechanization

In the late 1980's, if growth rates of the past decade continue, some airport terminals can be expected to have implemented even more advanced systems capable of handling larger and heavier containers than the 3- and 6-meter containers preferred now. Figure 7 illustrates a system which could increase the throughput of containers nearly 20 times over today's level.

Cargo volume is the major determinant of cargo terminal cost. As volume increases it is easier to justify systems that can dramatically reduce cost as well as provide faster and surer service.

Figure 6.— High Mechanization Elevating Transfer Vehicle (ETV)



SOURCE McDonnell Douglas Corp , Douglas Aircraft Co., *Cargo Logistics Airlift System Study (CLASS), Volume ///,* **prepared by R. D. Burby and W. H Kuhlman, under NASA contract No 1-14948 (Hampton, Va : Langley Research Center, National Aeronautics and Space Administration, October 1978), p 185.**

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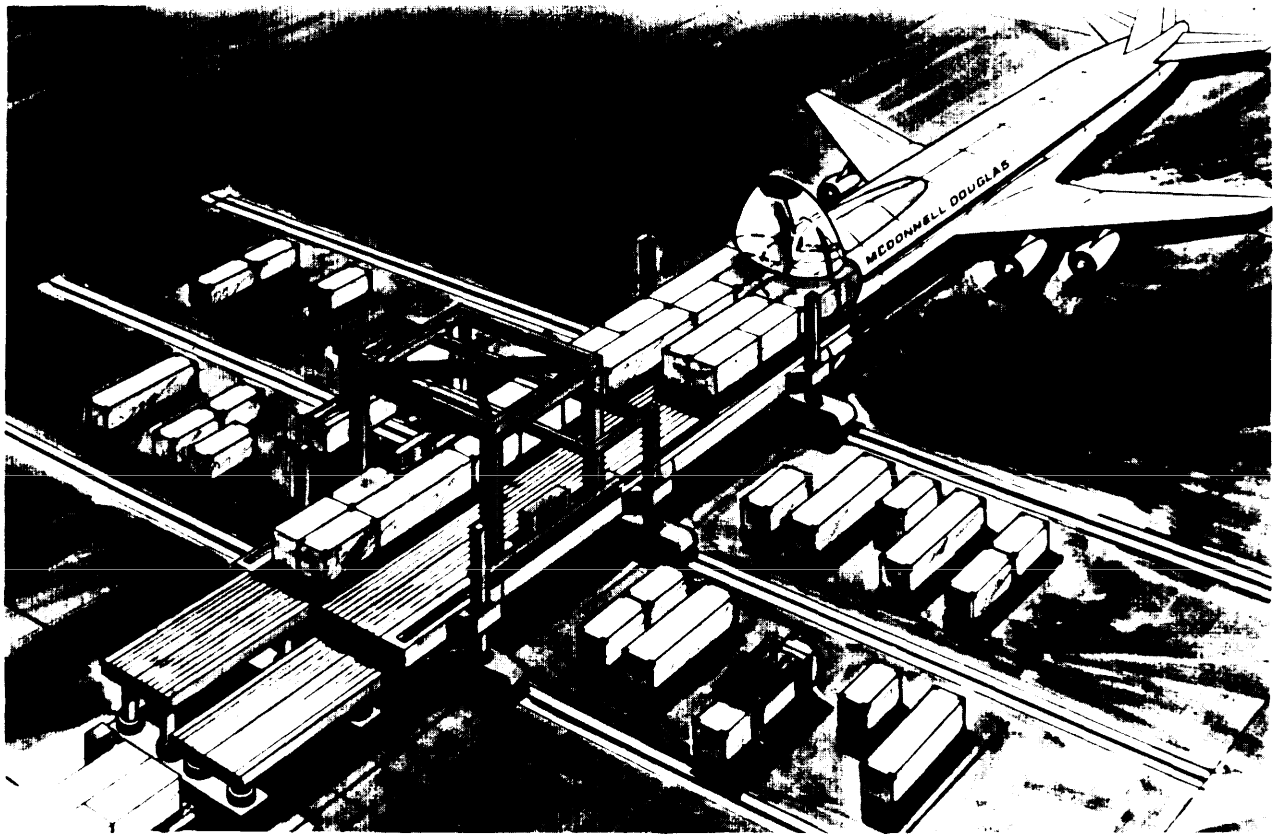


At each stage, mechanization must be designed carefully to minimize breakdowns and to allow the rest of the system to continue to operate in case of a breakdown in one component. Backup systems are also highly desirable. As the TWA case showed, it is possible to install systems too advanced for conditions, for- volume requirements, or for the technological state of the art.

An example of a very successful high volume operation that uses little in the way of mechanization other than conveyor belts is that of the Federal Express Corp., which specializes in providing overnight service for small parcels. [7]It has over 1,000 radio-dispatched trucks that collect packages on call throughout the' day. Alter the close of business, the parcels are brought to the airport stations and flown to Memphis is, Term. At Memphis there is a quarter-mile long sorting facility with a conveyor system capable of handling **130,000** parcels per night. This will expand to **150,000** per night by December 1981. The contents of arriving planes are unloaded into bins that are placed in a series of conveyor belts and sorted by destination. Containers are directly offloaded or onloaded but their contents may be hand sorted.

When the parcels are sorted, the outbound shipments are weighed, and the aircraft are loaded and dispatched. This entire process takes about **6** hours from the time the first airplane arrives until the last departs. More importantly, the time from the arrival of the last airplane to the departure of the first is only 1/1 2 hours. Fed-

‘Yupo Chan, and Ronny J. Ponder, “The Small Package Air Freight Industry in the United States: A Review of the Federal Express Experience, ” *Transportation Research*, September 1979, pp. 221-229.

eral Express now claims to achieve better than a 99 percent overnight delivery service rate for the small high-priority parcels that comprise the bulk of its cargo. Although Federal Express is now introducing a higher level of mechanization, this operation serves as a reminder that mechanization is not an end in itself, but merely one way to get a job done.

Degree of Containerization

Virtually all highly mechanized systems depend on containerization. Several methods of assuring a high level of containerization have been proposed including cost and service incentives to shippers and forwarders that containerize, thus passing on some of the savings from the mechanized system. Shippers who do not containerize could use a forwarder who does. The air carrier can also containerize bulk cargo. Although there is a cost to containerize, it is generally small compared to the savings in handling.

Table 2 contains estimates from a NASA study of the cargo handling cost per pallet or container under varying conditions of storage and handling. This analysis assumes that each system operates at capacity. It can be seen that cutting storage time in half for imports could save nearly 20 percent. Maintaining the shorter storage time while going from the current 40 percent average containerization rate to 70 percent would save an additional 16 percent; going to 100 percent containerization would save over 33 percent with no change in system. Using the single level ETV system saves nothing in unit cost, but the double and triple level ETV systems save roughly 20 percent and 30 percent, respectively.

Table 2.—Relative Cost Per Unit Loading Device[a] Under Varying Conditions

Degree of container-ization	International import storage time	Type of cargo handling system	Relative cost
40 "/0	3 day	Current	100 0/0
40 "/0	1.5 day	Current	81 .60/0
70 "/0	1.5 day	Current	75.30/0
100 "/0	3 day	Current	67.70/o
100 "/0	1.5 day	Current	57.7 "/0
100 "/0	1.5 day	Single level ETV	59.90/0
100 "/0	1.5 day	Double level ETV	38.50/o
1000/0	1.5 day	Triple level ETV	28.40/o

[a]e.g. Pallet or container

SOURCE McDonnell Douglas Corp , Douglas Aircraft Co. Cargo Logistics *Airlift Systems Study (CLASS), Volume ///,* prepared by R D Burby and W H Kuhlman, under NASA contract No NAS1.14948 (Hampton, Va. Langley Research Center, National Aeronautics and Space Administration, October 1978) P 222

With 90 percent off-airport containerization, these terminal improvements could reduce indirect operating costs by as much as 30 percent, with a resulting potential overall system rate reduction of up to 11 percent per air cargo shipment.[8]

Flexibility to adjust the size of the containers appears desirable. Currently containers of general cargo air freight are on the average only 54 percent full.[8] This reduces the efficiency of both the containers and the cargo aircraft themselves, which frequently “cube out” rather than “weigh out” — i. e., the available space in the aircraft is filled before its weight limit is reached. Use of containers of excessive size tends to exacerbate this situation, A modular container system has been proposed to minimize this problem. The system consists of a standard 8 by 8 by 20 feet intermodal container but made up of modules of 40 by 48 by 48 inches, which could be connected together to form the standard container or some container of intermediate size (see fig. 8). The design also allows complete disassembly for empty return. Boeing is also designing a version of this same concept.

Computerization

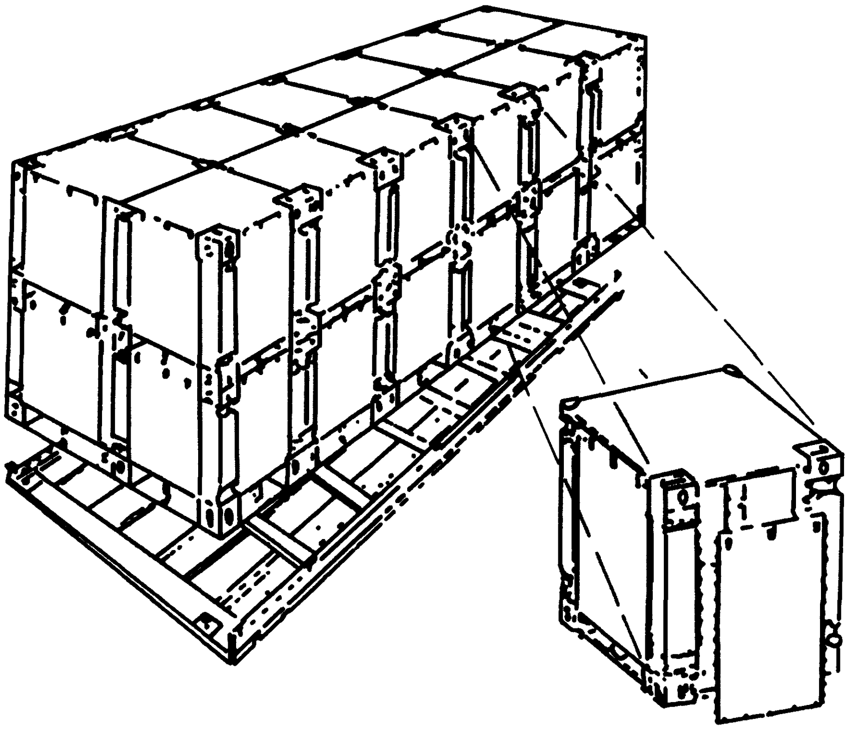
As the degree of mechanization increases, the degree of computerization is likely to increase as well. The basic functions of a computerized system are to generate the necessary documents, including intermodal waybills, to keep track of the shipments, and to trace lost shipments. However, many other management functions—such as billing and settlement, cargo space allocation, cargo scheduling and counting, and marketing—can be aided by manipulation of the basic data. Many carriers are already operating sophisticated computerized documentation systems.[10]

‘Allen H. Whitehead, and William H. Kuhlman, “Demand for Large Freighter Aircraft as Projected by the NASA *Cargo / Logistics Airlift System Study,”* NASA Technical Memorandum 80074 (Hampton, Va.: Langley Research Center, National Aeronautics and Space Administration, April 1979), fig. 3.

‘Taneja, op. cit., p. 212.

[10]Douglas, *CLASS, Volume 111,* pp. 188-189; Lockheed, *CLASS, Volume 1,* pp. 1-93.

Figure 8.— Modular Intermodal Container Concept Modcon Array and Adapter



SOURCE J L Weingarten, Closing the *Air* Transport *Gap on Intermodal Containers,* **Publication 73-1 CT-30 (New York American Society of Mechanical Engineers, May 1973), p.6**

PICKUP AND DELIVERY

Because virtually every air shipment begins and ends as a truck movement, it is necessary to improve the interface between truck and the terminal. Although intermodal containers designed to be used by both airplanes and trucks involve some weight penalties, the productivity improvement resulting from using containers is substantial. A study done in Europe found that labor productivity increased from 421 lb per man-hour for handling loose freight to 2,205 lb per man-hour for handling pallets or containers specifically designed for aircraft, an increase of 423 percent. Productivity increased to 4,778 lb per man-hour when intermodal containers were used, an additional increase of 117 percent. [11]

According to a Lockheed-Georgia study, the pickup and delivery (PUD) cost for shipment sizes less than 1,000 lb, using conventional methods, averaged over the 20 largest U.S. cities, is $3.35/100 lb at each end of the *movement*. This amounts to $134/ton, which when added to the computed average airport-to-airport cost of $175/ton yields a total of $309/ton. The use of an advanced technology aircraft and intermodal containers reduces the PUD cost to $86 and the airport-to-airport cost to $122, for a total cost of $208/ton. If a truckload-sized container is used, the costs reduce to $25/ton PUD, $7/ton container cost, and $122/ton airport-to-airport cost, for a total of $154/ton total. Thus total costs might be halved with advanced, intermodal truckload containers. [12]

''Taneja, op. cit., p, 212

'2Lockheed-Georgia Co., *Cargo Logistics Airlift Systems Study (CLASS) Volume 1* prepared by J. M, Norman, R. D. Henderson, F. C. Macey, and R. P, Tuttle, under NASA contract No. NAS1-1467 (Hampton, Va.: Langley Research Center, Nationial Aeronautics and Space Administration, November 1978), pp. s-s3 to 5-55,