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Boeing Spares Distribution Center: A World-Class Facility Achieved through Partnering

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PM Network, September 1994, pp. 9–19

Business Objective

One of the main reasons airlines buy airplanes from Boeing Commercial Airplane Group (BCAG) is the quality and speed of Boeing's customer support. A key element of customer support is rapid response and distribution of replacement parts. Boeing's new Spares Distribution Center (SDC), located in SeaTac, Washington, is the key to the company's worldwide reputation for customer service. Its design and operation will allow the Customer Services Division to improve responsiveness and extend Boeing's existing global reputation for the highest quality of customer service.

Background

In recent years, many Boeing customers have begun to use just-in-time inventory methods in their own operations to reduce the cost of storage space and inventory on hand. To achieve these goals, they have demanded faster turnaround on spare parts ordered from BCAG. By some estimates, it costs an airline approximately $50,000 in lost revenue per day when it has a plane on the ground waiting for a part.

As early as 1985, the Spares organization recognized that to be responsive to the changing demands of customers, it would have to change the way it was doing business. To accomplish that, it needed to identify areas for improvement.

One such area was that Spares operations occupied approximately 700,000 square feet in five buildings on three sites in the Puget Sound region. There was no opportunity to expand the operations at those locations. To accommodate a projected yearly growth rate in inventory and shipments, Spares would have had to fragment its operations even more by locating additional material storage and movement off-site.

Another opportunity for improvement was intra-region parts transportation logistics. Parts picked from one of four locations were transported to a single facility located in Auburn, Washington, and then processed and packaged for shipment to the customers. Travel time from there to SeaTac International Airport for shipping, which averaged forty-five minutes, was increasing due to worsening traffic congestion.

A 1989 study commissioned by Spares researched and documented these problems. The purpose of the study was to analyze existing operations and develop and evaluate alternatives. Facility, equipment, and operational solutions were based on a thorough understanding of current Spares business practices and how it intended to do business in the future.

The preferred alternative was to consolidate Spares operations into one facility on a site from which travel time to SeaTac International Airport in the year 2000 would be minimal. The recommendation approved purchasing a 27-acre site five minutes from the airport. An adjacent 10 acres were secured for future expansion. At that time it was concluded that the new SDC should achieve the following:

- create a cost-effective and integrated material handling system that was extremely reliable
- use employee input (through continuous quality improvement teams) to design work stations.

Most importantly, the new SDC had to improve the business and material flow for the distribution of parts.

Project Challenges

Siting Issues

Residential neighborhood. The new industrial facility is located on 27 acres, in a residential community immediately north of SeaTac Airport and south of the 175-acre North SeaTac Community Park. Sensitivity to the placement and appearance of this very large facility was critical to its acceptance by the community.

Noise mitigation. The close proximity of the project to the airport created unique design challenges requiring mitigation of outside noise transmission into the facility. Mitigation required the reduction of process noise transmitted into the surrounding neighborhood, such as those originating from exterior electrical generators and from the dust collection system. Conveyors were specified with cage roller bearings with a maximum noise generation level of 65 dB limits to reduce noise levels within the facility.

New municipality. The city of SeaTac incorporated as the project began. At the time the documentation for the State Environmental Protection Act (SEPA) was being prepared, it was not known whether the city or King County would perform this review. Furthermore, the fact that the city had never permitted a building project, let alone one as complex as the SDC, added to the complications in the permitting and building construction inspection processes.

The project team met with the city of SeaTac government and the community prior to the formal review process to discuss the scope of the project. Models of the building were developed to show how the new facility would look in the total context of the site and adjoining neighborhood. We listened to concerns throughout the program and explained what we were doing to answer them. On an ongoing basis, fliers and informational letters distributed among the community updated people on the progress of the project.

Specific examples of measures taken to ensure that the building would be as unobtrusive as possible and environmentally sensitive to the neighbor-

Boeing Commercial Airplane Group Customer Services Division

The Customer Services Division of Boeing Commercial Airplane Group is responsible for customer satisfaction during the service life of every Boeing jetliner. Today more than 7,250 Boeing-built airplanes have been delivered to airlines around the world.

It is the goal of the Customer Services Division to provide products and services that exceed customer requirements and to maintain the Boeing reputation for customer support. In 1992 customers rated Boeing service the best in the civil-airplane manufacturing business.

In addition to stationing more than 200 representatives to work beside operators daily in fifty-six countries around the world, the division employs about 3,000 people full time. These employees furnish spare parts and engineering support, train flight crews and maintenance personnel, and provide operations and maintenance manuals to ensure that airlines succeed with our airplanes.

The operating organizations in the Customer Services Division include Customer Training, Spares, Maintenance Engineering, and Field Service Engineering.

hood were the lowering of the building in the site approximately 20 feet in the southeast corner; design of indirect lighting to prevent perimeter and parking lot lighting projecting into the neighborhood; and design of an attractive, yet functional, landscaping adjacent to the neighborhood featuring a meandering trail with interpretive signs identifying the plantings.

Technical challenges. Stored within the facility is a total of 400,000 stock-keeping units (SKU) and over 1.3 million parts. Not only is the number of parts daunting, they range in size from extremely small, e.g., rivets, to significantly large, e.g., 767 engine cowling. The challenges occurred in two general areas.

Material handling. Our goal was to identify, purchase, and install reliable material handling equipment to achieve a low-risk start-up within budget. To accomplish this, we realized the need for:

- operational reliability at both the equipment and systems level
- design for local control of equipment initially, but to include a system link-up capability allowing for future migration to an integrated system and a total warehouse management system
- design to accommodate year 2000 requirements for the receiving, warehousing, shipping, and support functions associated with operation of the SDC.

Design flexibility. From the very beginning, the driving element in the building criteria required a configuration totally driven by its function. In the past, many of Boeing's facilities were created by constructing the building shell first and then making necessary functional changes after the client moved in. On this project, all users were involved in the initial planning and their requirements dictated the design. From the inside out, the building was wrapped around the processes.

The material handling and workstation requirements were developed concurrently with the design of the facility. As such, area configurations and material selection decisions were made to maximize flexibility and to accommodate changes as they occurred. In order for the project to be completed within the scheduled time frame, the building construction drawings had to be completed before all the necessary equipment and user workstation requirements were fully defined. Design allowances were initially made using parametric and experiential data to complete the missing information. As detailed information became available, these design allowances were reviewed and refined as necessary.

Distinctive Management Methods

From the beginning, the objective of the management team was to build and manage a team of people who would assume and share ownership in the process and the product of the SDC building program. Thus the program was driven by our mission, not by hierarchy or rules. The process differed substantially from normal Boeing procedures in these areas:

- A site-based management team provided the end users with a dedicated program team. This team provided the user with immediate access to the design process. End user input was proactively solicited to obtain an understanding of present operational processes.
- A different approach was used to move design changes further up in the design process. Traditionally, a scope of work is developed, an A&E designs it, and another company builds it. There is no continuity from start to finish as to why things happen. By the time you get to construction, the customer realizes that what he said (or meant to say) in the design meetings is not showing up in the building. Changes then occur during construction, significantly driving up costs.
- Lockwood Greene Engineering (LGE) established a project liaison office in Renton, Washington, consisting of a project manager, project architect, and project structural, civil, mechanical, and electrical engineers. These six people were transferred from Lockwood Greene's Oak Ridge, Tennessee, office to act as the focal point of coordination for all project design activities. Lockwood Greene's Oak Ridge office performed the actual detailed design for the facility.
- Boeing formed a teaming relationship with LGE in order to get away from the adversarial "us and them" approach of past projects. All major players were involved early in the project.
- The site-based user controlled the program budget. One of the program managers had signature authority.
- Keeping the program management team small enabled it to expedite consensus decision-making and utilize maximum flexibility.
- An extensive review of recently completed Boeing projects provided invaluable lessons-learned information related to material handling, control systems, contracting, and so forth.
- The new municipality of the city of SeaTac was brought in early in the project. This enabled its issues and concerns to be identified early in the design and made it a part of the project team. These agenda alignments of all parties greatly smoothed the planning and design processes.

Project Overview

Purpose

The purpose of the Spares Distribution Center (SDC) is to receive, store, and deliver replacement parts to Boeing customers operating more than 7,250 Boeing airplanes worldwide. The facility stores 400,000 stockkeeping units (SKU) and ships more than 1.2 million parts annually, operating twenty-four hours per day, 365 days per year. Parts for priority orders are shipped within four hours of receipt of the order.

Mission

Provide a consolidated SDC that will facilitate the reliable achievement of customer response time goals on all Spares transactions.

Objectives

- Accommodate year 2000 requirements
- Be functionally and visually consistent with the mission and image of Customer Services Division
- Invest in the wellbeing of SDC employees
- Be sensitive to and compatible with the surrounding neighborhood and land uses.

Overview

- 700,000 square feet
- High-bay area (storage)—60 feet clear height
- Mid-bay area (receiving, packaging, storage, shipping, and other process areas)—30 feet clear height
- Offices and employee services (commons, cafeteria, classrooms, fitness center)—35,000 square feet
- 300,000 square feet of super flat floors
- Eight-hour fire separation
- Maximum foreseeable loss (MFL) walls
- Redundant voice data communications
- 10,000 feet of conveyor for conveyorable totes
- Nine hybrid vehicles
- Forty carousels, each 80-feet long, for small parts
- 1.6 million gallons on-site, underground water detention (two tanks)
- Extensive and redundant sprinkler coverage
- Removed 440,000 cubic yards of dirt
- 316 miles of fiber-optic cable for data communication.

Project Scope

The original scope of work, developed by Boeing, contained a building design criteria document. This was primarily a macro-level overview of the facility, not a detailed requirement definition document. Extensive interviews and meetings over a year-long period determined the actual detailed requirements. However, many times throughout the criteria development phase, the team was challenged to differentiate between real needs (hard requirements) and perceived needs, or wants (soft requirements).

Facility

The primary configuration control document became the coded layout: a detailed, to-scale architectural floor and equipment plan of all features of the facility and site, on which every item had an identifiable code. This was the primary document against which all other emerging changes were "tested" for compatibility and coordination.

All design issues were documented, tracked, and statused on an action item list. Individuals were assigned the accountability for the item with a specific due date. Action item lists were reviewed and updated weekly at the regularly scheduled project team meetings. The appropriate resolution was presented to the complete design team for review prior to its implementation.

It was intensely challenging to manage scope changes and still maintain three major project milestone reviews. Extensive meeting minutes were maintained to document changes, in addition to updates of the coded layout. Specific milestone reviews were based on change control as opposed to continuous changes. In order to catalog the numerous design changes, design logs by discipline were initially maintained to provide visibility to the design team.

Material Handling

As the program got under way, a series of trade-off studies further refined our understanding of the advantages of various kinds of material handling equipment. These studies were of critical importance to the entire SDC equipment program and exerted a ripple influence on most subsequent decisions relating to building design and construction. These analyses included:

- miniload automated storage and retrieval system (ASRS) versus carousel system
- hybrid vehicle versus narrow aisle man-up order picking vehicle
- two-level versus single-level carousels
- rack-supported storage versus self-supported building roof for high bay storage area
- vertical carousel versus horizontal carousel system
- bulk floor stacked versus rack storage
- carousel system automation
- column bay spacing for high-bay building columns.

Because the SDC building design wrapped around equipment requirements, processes were not constrained by predetermined space availability beyond the design goal of using space efficiently.

The scope of work for the material handling element of this project developed through observation and review of present work practices and processes. The results of these efforts formed the foundation of understanding for Boeing's method of doing business. From this foundation began the identification of opportunities for improved methodologies that could be designed into the new facility.

Following the initial observation and orientation phase, extensive interviews and work sessions with the facility user representatives were held to "brainstorm" ideas for improving every aspect of their daily work lives. These ideas were then subsequently organized by general category. With many of its own ideas, the material handling team developed alternatives and options.

Process flow diagrams and dependency charts that were developed ensured the optimum layout of all process areas.

A detailed and comprehensive narrative describing each process center operation was developed. These documents described how each individual system operated, with particular emphasis on its interface with the material handling equipment.

As various material handling ideas were developed, freehand sketches, 3-D perspectives, floor plans, etc., were used to clearly illustrate concepts and ideas and to provide visual augmentation of the final product to the various lay users.

As mentioned above, the coded layout became the primary configuration control document for all team members. As the configuration of "bricks and mortar" and material handling features were merged with the facility requirements, they were documented on the coded layout. Any conflicts were promptly identified and addressed, and mutually beneficial solutions were developed.

As the material handling concept became more solidified, the systems were simulated using Automod 2e. This provided confirmation of the adequacy of each of the three subsystems as well as the entire integrated system to function to the desired performance criteria. The results from these simulation tests showed how quickly all the myriad parts and sizes could be moved through the system.

Cost or emerging functional requirements typically drove changes. Identified changes were discussed in weekly material handling team meetings. All team members were encouraged to participate in discussions on design alternatives, design concepts and approach, and selection of particular design options.

Material handling changes impacted the project in many different ways, including "brick and mortar," system functionality, cost, schedule, user acceptance, and system reliability.

In order to determine optimal design configuration, actual data was collected and summarized whenever possible.

Whenever conflicting requirements emerged, the project team always referred to the project's mission and objectives statements to provide the basis for compliance.

Examples of changes occurring during the design are adding five rows of high-bay racks and four hybrid vehicles; adding a tote take-away conveyor in the high bay to improve system response time; redesigning totes to be constructed of a fire resistance material to satisfy the fire inspector's requirements; reducing the size of the conveyor tote from 36 to 30 inches to improve ergonomics; and extensively evaluating and refining the conveyor/carousel workstations.

Control Systems

One of the fundamental project ground rules was that the project must be "low risk" on start-up. Boeing mandated that the performance of the new facility would not be dependent upon a very sophisticated control system that would take months to debug. However, the system had to have the flexibility to expand its automation capabilities as the needs of the facility dictated. In response to those needs, LGE implemented a successfully proven methodology to fully define immediate as well as long-term requirements:

Requirements definition specification (RDS). The specification was developed through extensive interviewing sessions with owner representatives

FIVE MANAGEABLE TRUTHS: A PATH TO PARTNERING

1. Individual and company attitudes and plans are moving from a short-term to long-term focus. *As a result,*
2. Buyers and sellers must transition from event-driven transaction to consultative- and relationship-driven partnership. *And to support this,*
3. Commitments of greater magnitude must be exchanged between partners who will then function synergistically in a complementary relationship. *And to maintain this high-level commitment,*
4. Companies will continually leverage greater expertise into their first-tier clients to gain proprietary value for their customers. *And to provide additional value,*
5. Companies will shift from offering their services at fixed cost to conducting business with their partners on a variable cost basis.

from cross-functional groups. This document described in broad terms what the control system was to do. It also defined the migration path to add additional levels of warehouse automation as the needs arose.

Functional definition specification (FDS). This document described the architectural functionality of the control system. It defines how the system will be configured, organized, and modularized so that additional levels of automation may be conveniently integrated.

Customer requirements to standardize equipment across vendor boundaries and to increase the product-tracking capability of the systems drove scope changes. Changes were managed through the request for information (RFI) process from the owner to the vendor.

One of the material handling vendors was requested to change from this standard bar code scanner to another brand of scanner. This change allowed the owner to have a single brand of scanner, which reduced training and maintenance costs. This vendor experienced problems integrating the scanners into this product. Fortunately, these problems were identified during system prototyping and resolved during the site acceptance test.

Another change included adding additional fixed scanners to the conveyor system in order to track the tote to its final destination. This change will allow for the tracking of parts in the totes when future automation is implemented.

QUALITY MANAGEMENT

As previously mentioned, the philosophy of the management team was to build and manage a team of people who would assume and share ownership in the process and be accountable for the product of the SDC building program. Thus the program was driven by our mission, not by hierarchy or rules. This process differed substantially from normal Boeing procedures in these areas:

- The core design and user team was maintained throughout the entire project life-cycle, from conceptual development through start-up, commissioning, and post construction. This added not only to the stability of the project, but ensured that the owners' and designers' intentions were correctly interpreted, implemented by the contractors, and functionally validated as the process went into actual usage.

• The core design and user team supported directly and indirectly the users' quality improvement teams, meeting with them to develop work-station design, color schemes, and other aspects of the new facility that would influence the quality of their working environments.

• In order to achieve quality construction and procurement documents, formal user reviews were performed. Major design review milestones at 30, 60, and 90 percent were conducted on the facility construction documents both by peer reviews conducted by an independent consultant and review by Boeing facility engineers.

• The equipment procurement specifications likewise underwent thorough milestone reviews. The "brick and mortar" review team had input into the material handling specifications to ensure that all interface conditions were coordinated and had indeed been incorporated into the documents. In addition, comments were solicited from prequalified equipment suppliers and incorporated into the specifications prior to the actual bid release.

• User review comments were documented. Each comment had to be specifically addressed and satisfactorily resolved by the designer prior to the next milestone review. In cases when comments were in conflict, the designer met with the individuals or groups initiating the comment and facilitated the development of a consensus solution.

• A factory acceptance test for the integrated material control (IMCS) and graphics control system was required in the specifications and was a major factor in trouble-free installation and commissioning.

Time Management

Time management for the project was implemented through an integrated critical path method (CPM) project schedule, an integrated action item list (with due dates) that was updated weekly, and required recovery plans for critical tasks that were behind schedule. Since the project schedule was integrated for all participants in the project, impacts on the material handling vendors from delays in construction were identified early and costs were minimized through advance notification and planning.

Facility

Major project milestones were:

Building conceptual design, design development, detailed design, issue for permit	3/90–4/91
Permitting, bid addendum	4/91–6/91
Building construction	9/91–3/93

Scope adjustments and their causes. As a strategy for managing planned changes, the coded layout was "frozen" at a particular date. This gave the design team a fixed target to work toward. Meanwhile, the liaison team continued to meet with Boeing to refine project requirements. These changes were documented and tracked to ensure incorporation at the next deliverable milestone. As a result, the completed building required very few user modifications to the final design.

In addition, the building configuration was designed to directly respond to and be driven by the various material handling processes. This led to another major challenge. These processes were being defined and refined concurrently with the development of construction documents for the building. By working closely together, the material handling team members were able to provide the facility designers with their "best guess" of the material handling equipment configurations at the various interface points. As a result, a significant amount of flexibility was designed into the facility to accommodate installation and future operational changes.

Extremely late and evolving requirements imposed upon the project by a newly hired fire inspector for the city of SeaTac generated the primary construction delay challenges to the project. These requirements significantly impacted the fire protection and fire detection systems installations. Of the problems encountered on the project, this one almost became the "show stopper." The requirements imposed were very stringent and very late in the construction process. Extensive meetings with SeaTac officials were required to:

- fully disclose and understand the city's requirements
- negotiate whenever possible more realistic interpretation of code requirements
- develop equivalences that would satisfy the intent of the code and ease the safety concerns of the official while maintaining the integrity of the original design and minimizing the cost to the owner.

This was done over a five-month period. In order to minimize disruptions to the contractor, it was done with an extreme sense of urgency by the program team.

Material Handling Equipment

Major project milestones were:

Initial conceptual design	8/90–12/90
Finalize conceptual design	1/91–3/91
Generate bid specifications detail design	4/91–9/91
Bidding	10/91–12/91
Equipment manufacturing	1/92–7/92
Equipment installation	8/92–2/93

Major delays in equipment installation resulted when the building contractor was unable to complete and turn over for joint occupancy the required building areas.

Control Systems

The schedule for control systems followed the material handling equipment schedule. There were no delays in the project due to control systems because of the rigorous design, programming, and testing requirements on the vendors.

Cost Management

In order to ensure compliance with the project's budget objective, a design-to-cost approach was taken for the entire project.

Facility

LGE developed a conceptual grade construction estimate using a parametric approach as early as the 15 percent design development stage. Concurrently, Boeing's estimators prepared an independent cost estimate. These two estimates were subsequently compared and reconciled, with the resulting dollar value becoming the target number for the constructed costs.

At the conclusion of the 30 percent milestone, another construction estimate was prepared. At that time it appeared that the cost exceeded the budget. A value engineering analysis of the facility, prepared by the design team, resulted in the identification of approximately fifteen items for cost reduction consideration. This analysis included the values of probable construction costs. The advantages and disadvantages of eliminating each item were discussed. Through this process, the program eliminated approximately $2.5 million in additional construction costs without adversely affecting the building's functionality or appearance.

Material Handling

A very similar approach was taken with the material handling equipment. To add additional levels of confidence into the estimating process, input for installed costs provided by various vendors for conveyors, racks, hybrid vehicles, etc., were factored into the cost estimate.

At the end of concept development, the cost of the conveyor system had to be reduced by approximately $600,000. To accomplish this, the amount of conveyor equipment had to be reduced. To achieve this, it would be necessary to bring cultural changes to people that managed the operation. This required changing the process from a "batch" to a "continuous flow" operation. With cost reductions as our objective (and shield), we were able to drive the group to focus on improving the process. The material handling designers were now free to design a system that would improve the existing methods of warehousing and distribution.

Existing carousels, mid-bay racking, etc., were reused whenever feasible as an additional cost-saving strategy.

The entire team was aware of the budget status for each of the major elements, and was committed to achieving the objective.

Risk Management

External Risks

Permitting by a new municipality. As previously mentioned, the very first formal project document prepared to obtain project approval was the SEPA checklist. This document requires all governmental agencies to consider the environmental impacts of a proposal before making a decision. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The checklist is submitted to the agency having jurisdiction (AHJ) and describes in broad terms the scope and magnitude of the owner's planned development.

Because the city of SeaTac incorporated as a municipality only months prior to the start of the project, it was not known whether the city or King County would perform the checklist review. Furthermore, the city had never reviewed and issued a building permit, let alone one as complex as the SDC, and that created additional complications in the permitting and building construction inspection processes.

Acceptance by the local neighborhood. A facility this large was definitely going to have an impact upon the character of the surrounding neighborhood, during construction as well as during the operational life of the facility. The last thing the project needed was to alienate the community and create opponents who would object to the project, possibly delaying it or perhaps canceling it altogether. It was imperative to make friends of the neighbors, be sensitive to their concerns, mitigate the impact of the facility upon the adjoining neighborhood, and to keep the neighbors well informed of the project status and progress.

FAA approval. The project was extremely close to the flight line of the eastern runway of SeaTac Airport. As such, many of the physical properties of the facility had to be in compliance with FAA guidelines. This included such issues as the maximum height of the high bay, exterior building color, site lighting, reflective characteristics of the building siding, and construction crane height.

Internal Risks

Control system. As mentioned before, a low-risk start-up was one of the fundamental ground rules of the project. Boeing project management considered the control system design and implementation as potentially high risk to the project. Custom software development with extensive sophistication and complexity could have increased design costs and jeopardized the overall schedule.

In order to mitigate this risk, a delicate balance was created between project team members and Boeing management and maintained through proactive communication and team-building skills. This balance required that the pertinent people within the Boeing company be actively involved during the initial development of the control system requirements, in order to obtain their buy-in of the approach. The design and subsequent development of the control systems were developed by the control systems suppliers, which minimized the project risk. These suppliers were managed by the project team's system specialists to enforce strict adherence to the performance requirements. Throughout the implementation phase, Boeing managers were statused frequently on project progress.

Material handling. The mechanical and control systems of the material handling equipment had to have an uptime of 98 percent in order to meet the performance objectives of the project. Because of poor performance on recently completed projects, there was a significant amount of skepticism.

The material handling system had to be 100 percent operational on the day the facility opened. With a tight budget and construction schedule, this meant that there was little margin for error in the design process. All factors had to be considered, everyone's needs had to be met, and on day one, all the systems and processes had to function as designed.

Managing extensive user input. From the beginning, it seemed as though the project was inundated with extensive user comments. These comments were simultaneously late emerging, contradictory, and often confusing. At almost anytime, it seemed as though these had the potential to effect a major impact on the project schedule and budget.

Use of outside consultants. As with any new endeavors, the use of outside consultants was viewed with various degrees of acceptance from the user groups (Boeing Facility), as well as from other support groups. Each

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thought it had the capabilities to go it alone. Developing credibility, trust, and acceptance was challenging but critical to the success of the project. In all the cases cited above, the true key to defusing the situation was simply communication, communication, communication. Sure, there were technical problems to resolve and implement, but constant communications led to mutual understanding. Together with strong dedication to positive interpersonal skills, the walls were taken down brick by brick.

Team Development and Human Resources

Team Development

A partnering relationship must be created throughout the entire team. While this is the current "buzzword," the words and the music must be consistent for this truly to be effective. To do this, the deep adversarial relationships had to be significantly reduced, if not eliminated altogether. Meetings were conducted in a non-threatening atmosphere where everyone felt free to discuss problems and ask for help. Resources were assigned to address emerging problems based upon expertise, not along employment affiliations.

In addition to the formal weekly meetings, there was an informal weekly team-building breakfast meeting that brought together the Boeing management team, engineers, and contractors. The meeting was completely off the record, allowing all participants the opportunity to vent their feelings and frustrations, modify expectations, and so forth, with impunity.

Other team-building tools were:

- promotion of enthusiasm through planned and spontaneous recognition that was personal, specific and timely (The project developed a logo, which was applied to all manner of items—hats, cups, notebooks, key chains— and given to people to show that they were appreciated for the job they were doing.)
- instigating numerous planned and impromptu potlucks, coffee, and doughnut breaks, working lunches, celebrating birthdays, celebrating project progress at every major milestone; e.g., groundbreaking, topping out, etc.
- off-hour award ceremonies sponsored for key participants and their families, including users, Boeing consultants, and representatives of jurisdictional authorities.

All of these activities were genuine and sincere, and collectively stated that each team member's efforts were recognized and appreciated.

Team Contribution to Project Success

By developing individuals into a motivated, focused work team, the entire team was dedicated to the success of the entire project, not just the specific areas for which they had specific responsibilities. Some examples are:

- The "brick and mortar" review team had input into the material handling specifications to ensure that all agreed that interface conditions had indeed been incorporated into the documents.
- Detailed equipment drawings were submitted to the facility design team for review at critical interface locations such as floor and ceiling supported equipment, electrical panel loads and location, and for final interface review.
- The team collaborated to achieve mutually satisfactory solutions whenever constructed or installed conditions differed from the as-planned condition. Specifically, the high bay take-away conveyor was a late addition to the project. The roofing system could not accept the additional equipment loads without significant structural modifications. After deliberation, it was decided that a floor-supported system could be used without any detrimental effects to the functionality or appearance of the building.
- Contractor questions or additional information requests were tracked and closely monitored; need dates were specifically established in order to eliminate or minimize any unplanned activities. Emerging situations were aggressively and proactively managed. To prevent contractor rework in the cases where the contractor installation deviated from design drawings, the engineer made every effort to make the installed condition work. Savings or credits to the owner were, however, aggressively pursued when appropriate.

Contract and Procurement Management

Material Handling Equipment

The material handling equipment (MHE) procurement and installation were managed by the program team. Prescriptive specifications were submitted to prequalified equipment vendors to solicit RFQs on the three major pieces of equipment; i.e., conveyors, high bay rack with hybrid vehicles, and carousels. Through a detailed bid evaluation process, the "best bid" was selected. The MHE integration team managed the design, fabrication, installation, and start-up by the MHE vendors. Contract management and control was streamlined with technical or contractual issues promptly addressed.

Facility Construction

The contractor was selected through a competitive bid process, after first pre-qualifying and developing a general contractors bid list. The contract was awarded to a general contractor based on the apparent low lump-sum bid and best schedule. The contractor self-performed general carpentry and concrete work, subcontracting all other work to local specialty contractors. The contractor was responsible for all coordination, scheduling, site supervision, etc., among all trades.

The contractor was responsible for the completion of specific building areas to achieve joint occupancy, allowing the installation of the material handling equipment in one area while building construction activities proceeded in others. This included coordinating with others to permit the transition and usage of the designated area.

This method provided the owner single-point responsibility for the coordination and construction of a very complicated facility, while at the same time providing the flexibility for early completion of specific building areas, allowing early starts on the MHE installation.

Communication Management

Boeing was committed to involving all levels of the user's management and staff in this project. Because of the significance, complexity, and sophistication of the project to all its stakeholders, the level of owner, community, peer, and municipality review was rigorous and thorough. Furthermore, because these stakeholders represented a widely diversified understanding of many of the technical issues associated with this project, all means of communications were necessary to convey thoughts and ideas to the various audiences. This included three-dimensional perspectives and sketches, scale models, automation simulation of the material handling equipment, architectural renderings, newsletters, etc.

Communication—formal and informal, internal and external—was characterized by entrepreneurial enthusiasm. It was transactional and horizontal rather than directed and vertical. Roles and expectations of all participants were established early, identifying how they fit into the larger picture and what we wanted them to do.

Summary

The successful execution of the Spares Distribution Center project can be directly attributed to the following factors:

- total project team commitment to the partnering concept in order to create a "win-win" relationship (Team members were held accountable for task assignments.)
- creation of "ownership in the project" by soliciting input from all stakeholders in the initial design stage
- effective communications with all project stakeholders (proven methodology for change control)

- true understanding of the functions and processes before designing a facility in order to correctly meet those needs
- provision of an integrated approach and solution to engineering- and business-related problems
- a "low risk" start-up approach for the material handling control systems.

Study Questions

Boeing Spares Distribution Center: A World-Class Facility Achieved Through Partnering

1. Boeing's new Spares Distribution Center (SDC) project was very successful. From the case and your experience, what are the key elements that contributed to the project's success?

2. The case states: "As early as 1985, the Spares organization recognized that to be responsive to the changing demands of its customers, it would have to change the way it was doing business." Change is inherent in today's organizations and business environments. Discuss some of the major changes that companies are facing today.

3. The management of this project used a very effective method to deal with arising conflicts in the project. Describe the method.

4. This case discusses the use of "partnering" to manage relationships with customers. Describe what is meant by partnering and discuss its benefits.

5. The schedule on this project was managed using the critical path method (CPM). Define CPM and discuss its strengths and weaknesses.