

Delta's Operation Clockwork

Transforming the fundamentals of an airline

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About the author

Lucio Petroccione Jr. is a seasoned airline executive with over twenty years of industry experience. His career includes executive positions with Pan Am World Airways and Delta Air Lines. Lucio has had extensive experience in the critical areas of Strategic Planning, Business Development, Marketing, Network & Schedule Development, Airport Customer Service, Operations Management and Technology Development.

In 2005, Lucio was the architect and led the corporate implementation of the largest major redesign of Delta's Airline Network in its history – Operation Clockwork. It was also the largest Network and Operational redesign in aviation history.

Lucio is currently the Principal for Decision Strategies' Transportation and Logistics group responsible for leading a wide range of major consulting assignments in a variety of industries.

This paper is printed with the approval of Delta Air Lines.

Executive Summary

Delta implemented the largest airline network restructuring in the history of aviation called Operation Clockwork. The majority of the airline's revenue generating capacity was moved around in one night. Gerald Grinstein, Delta's CEO, shared his perspective at the annual shareholders meeting in Atlanta on May 19, 2005. *"If you have to put your finger on one thing that could fundamentally change the direction of this airline, it is Operation Clockwork."* This transformation set the stage for a new business model to achieve the highest possible efficiency and lowest possible cost for the airline. It started a major transformation from a legacy carrier with its high cost structure to a business model that can compete and win in today's battlefield.

Background

A decade-long commoditization trend has firmly established the operating cost structure as the real battlefield for competitive advantage. In the end, everyone will be striving for the same objective, that is, to create the lowest cost business model that will achieve the highest efficiency while growing revenues. This is significant because it equalizes all the carriers, LCCs and Legacy carriers from a cost perspective. It removes the most powerful competitive advantage (the ability to set prices) away from any single carrier or group of carriers. Achieving the lowest cost model is also crucial to long term success given the permanent introduction of higher fuel prices and the uncertainty and risk it brings into the airlines cost equation.

To address this in a strategic manner, rather than arbitrarily slashing expense line items by negotiating large labor concessions or re-negotiating capital lease payments, companies need to re-design fundamental changes into their operation for a sustainable business model. Such transformation can create new growth opportunities by enhancing throughput, enhancing the productivity of assets and relieving real capacity constraints. In many cases, their entire business model should be transformed to achieve the target efficiency and cost structure required to win in today's competitive environment.

Historically, companies have chased short-term cost cutting solutions that ultimately proved to be unsustainable and inflexible in the marketplace. However, those that aim to drive sustainable market presence, competitive advantage and strong shareholder value approach the problem from a long-term strategic perspective. They transform their business to continuously adjust to ever changing economic and market conditions. Confidence in design and perseverance in its execution are key factors. Transformation must be viewed as a journey, not an end state. Only over a period of years - not months - will it become evident how well the new business model will perform.

Airline Business Model and Constraints

This paper is the story of one airline's transformation efforts. The commercial aviation industry is unique as a production "factory", with the perishable nature of its primary

product flowing out of each airport as its factories. The product, available seats to a number of locations at a particular time of day, is the perishable commodity. There is no way to recapture that product and value once the plane departs if a seat is empty. The seat cannot go on a shelf waiting to be purchased the next day.

The airport-factory is dependent on receiving the inventory of seats, i.e. the arriving aircraft, which produces available seats to leave the airport. The steady, reliable delivery of inventory is highly dependent upon an independent vendor and upon meteorological factors. Both variables may appear to be beyond the airline's control. For instance, the Federal Aviation Air Traffic Control System (ATC) is responsible for the delivery channels and capacity of aircraft to the airport factories on schedule. Airlines can sometimes influence ATC outcomes, but they cannot directly control them. Weather, a constant and unpredictable component, further contributes to the complexity of delivering inventory where and when needed. The airline's themselves have limited control on the impact and timely delivery of inventory in conformance to their production schedule (the flight schedule). An area where airlines have some influence on this capacity is through their network design and schedule. All of these elements are directly linked, subjecting the process to a high degree of variation, which in industrial terms creates a defect rate impacting the timely availability of capacity compared to the planned schedule.

Once the inventory, the airplane, is on the ground, the factory strives for optimum throughput levels in order to ship the newly available seats back out of the factory. The cycle repeats itself over and over, and success is dependent upon a steady, predictable throughput rate of production. In order for the airline to survive and thrive, it must reliably deliver the inventory, profitably fill and deliver the seats in a highly variable economic and operational environment, and keep the costs well below the market price.

Pricing power has steadily diminished over the past decade with widely available pricing information for consumers to compare and the overcapacity of available flights in many markets. Due to steadily rising capacity (adding ever more seats and airplanes to markets and hubs), the tolerable margins of error for achieving operating profitability has decreased for the industry overall. In such conditions, dependence on the productivity of a major outside vendor like ATC is quite amplified. The success or failure of current airline business models depends more than ever on the uncontrollable variables of ATC capacity control and on the weather. Optimizing network design is no longer sufficient; survival in today's airline industry literally depends on **excellence** in network design and consistent rigor in day-to-day execution.

Case Study – Delta Air Lines Operation Clockwork

Delta Air Lines' operation at Hartsfield-Jackson International Airport in Atlanta is the largest and most complex transportation hub in the world with over 1000 daily flights and over 30 million passengers per year. It represents over 50% of Delta's total operation, and generates over 70% of its revenue. The business situation faced by Delta in 2004 and the transformational strategy developed as Operation Clockwork is the background for the case study described in this article.

In 2004, the carrier's ability to grow the hub was constrained by both operational and financial issues. The available facility and airspace utilization had peaked, with no room for increased flight activity. Overall reliability was negatively impacted by limitations on airport airspace and runway capacity. Dependence on the Air Traffic Control system to optimally manage the flow of aircraft was increasing. Performance was steadily trending down. Last, but not least, the airline profits were eroding as it struggled to compete with fast growing low cost competitors.

The Transformation Process Begins

To address these issues, Delta implemented the largest network restructuring in the history of aviation on January 31, 2005. It was called Operation Clockwork. Every aircraft, market and employee was touched in some way. A total of fifty-nine percent of the Network was rescheduled, with the execution of the new operating plan done in a single day, an accomplishment never achieved before.

The most dramatic change was the implementation of a new network and schedule structure design in the largest airline hub in the world – Atlanta Hartsfield-Jackson. This change marked the beginning of a transition to a new business model for the airline.

The Objectives were:

- To profitably grow without additional capital expense;
- To improve in schedule reliability and quality while reducing the dependence on the uncontrollable variable of ATC to control the delivery of inventory (aircraft) to the production facilities (airports); and,
- To achieve a cost structure and competitiveness against younger leaner, low-cost competition and against restructured legacy carriers.

To achieve these objectives required a dramatic change in thinking about the airline's network and operations. The first step was to optimize the scheduling of the fleet. The initial focus became "turn times" - *i.e.* the amount of time an aircraft is on the ground between arrival and subsequent departure. Evaluating incremental ways of improving system productivity allowed the network to maintain the revenue capacity with fewer aircraft. This yielded the equivalent of nine "free" aircraft and brought improved efficiency throughout the system. This "turn time" initiative reduced standard turn times by 15-20 minutes on narrow-body equipment to an average of 45-50 minutes - a 22% percent improvement, with ongoing refinements to bring turn times even lower.

The next step was to reevaluate the fundamental basis of the structure of an airline hub schedule, namely "banked" versus a "continuous" operation. As background, a "banked" hub is built around the grouping of arrivals and departures of aircraft within certain routine periodic time intervals. The primary goal is to provide the maximum number of connections between cities served by the hub within those time intervals to drive as much revenue opportunity as possible. Therefore, by design, the "banked" structure attempts to

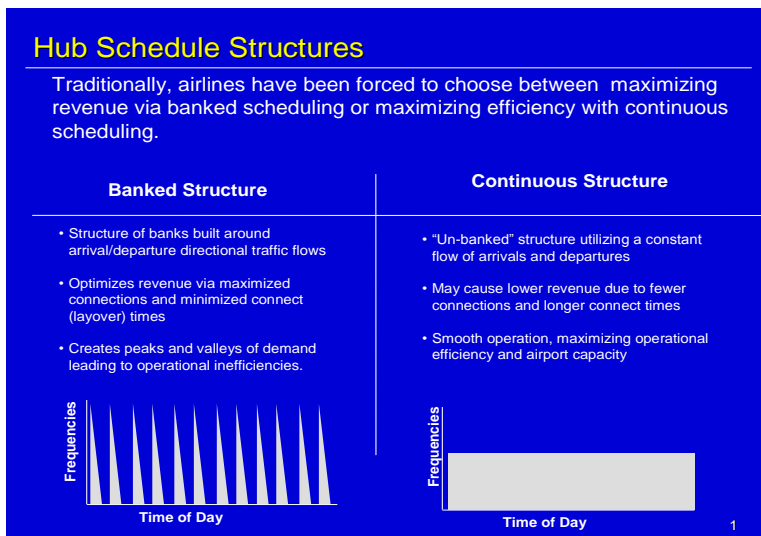
maximize connections (and thus revenue). However, it compromises asset efficiency (aircraft and facility utilization) and employee productivity. Aircraft sit on the ground under-utilized while waiting for the start of the new bank, and airport staff personnel are overworked during peak levels of operation, while underutilized in off-peak times.

Conversely, a “continuous” operation structure is by definition a constant flow of arrivals and departures throughout the day. The goal of the “continuous” operation is to maximize operational efficiency and airport capacity, with highly utilized aircraft and a more average staffing level required at hub airports. However, this solution has been viewed to work at the expense of revenue maximization, i.e., simply landing and departing aircraft as quickly as possible to strive for maximum efficiency, and losing much of the connecting revenue potential. Prior to the design of Operation Clockwork, a “continuous” operation had no form or no connection logic. This initiative addressed both objectives, with a joint optimization of operating efficiency and revenue potential.

What if you could combine the revenue generating power of the traditional “banked hub” with the operational efficiencies from a smooth “continuous” schedule?

Historically, increased numbers of connections and appropriate connection times yielded incremental, high-paying passengers. The higher revenue justified having a slightly suboptimal use of aircraft and airport personnel resources. In today’s market, however, connection passengers pay low fares (purchase decisions are more driven by price versus connection times), while human resource costs have skyrocketed. The traditional thinking about revenue potential versus operating efficiency had to be fundamentally rethought, given that these basic parameters of the airline business have permanently changed.

Delta’s Atlanta operation provided a critical mass to seriously consider a “continuous” hub operation with little damage to connection integrity (revenue). The key difference from the traditional hub model’s assumption that maximum revenue is achieved through



banks of flights (and directional connecting passenger traffic flows) was to have the new “Continuous” model built using a high frequency of service between the top revenue producing markets as the foundation for the operation. These “foundation” markets generate approximately 80% of the connecting traffic and 70% of the originating traffic in the

hub. Establishing a continuous pattern of flight options to these markets improved the frequency of service for customers. In addition, a carefully orchestrated re-fleeting of the

entire network adjusted the capacity (number of seats available) on each flight and in each market, maximizing the profitability of the entire network.

A number of carriers have also redesigned their major hubs. For example, American's new network design at their hub in Dallas was an attempt to smooth out the arrivals and departures throughout the day. American's new structure focused primarily on operational efficiencies. Embedded in the structure were smaller well defined directional banks. So even though it reduced the number of arrivals and departures per hour, it still adhered to the traditional assumption that maximum revenue is achieved through banks of flights (and directional connecting passenger traffic flows). American's new structure is better defined as "rolling" hub versus Delta's new "continuous" hub design.

Having solved for the revenue issue, the focus went to achieving the operational efficiencies and high reliability made possible by a continuous hub structure.

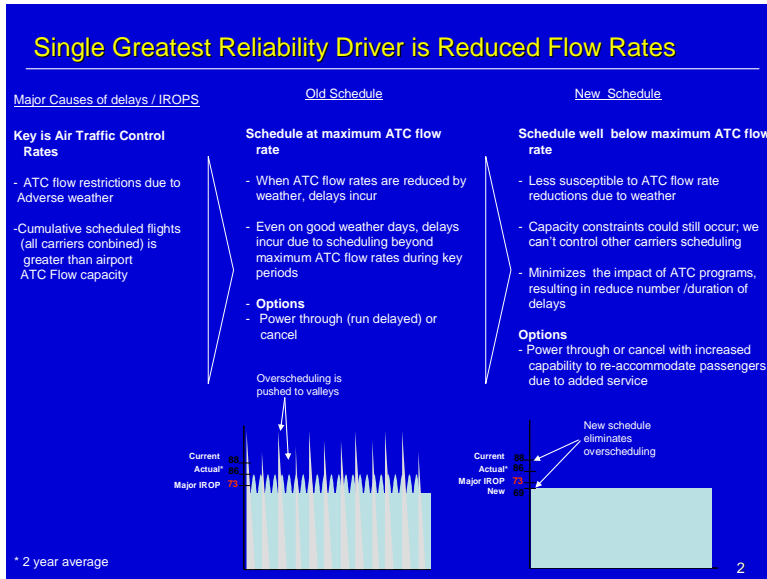
Low Capital Investment

A critical factor for success of Operation Clockwork was to transform the operation with no capital investment in additional aircraft or facilities. The "continuous hub" schedule combined with a reduced turn time operation created huge aircraft and facility efficiencies. The scheduling efficiencies drove a ten percent increase in daily aircraft utilization, freeing up nineteen (19) aircraft to be reinvested back into the network for additional revenue generation opportunities. The "virtual" benefit of those 19 aircraft was in the neighborhood of \$500 million dollars in capital that did not need to be invested. Additionally, eight gates and parking positions that did not exist under the current network design were freed up, allowing the capacity to grow with the 19 aircraft. Maximizing the use of all assets provided the capability for future growth of over 120 daily flights. Everything was self-funded using the efficiencies gained through redesign.

Enhanced Competitiveness

This growth has strengthened the airline's competitive position in the Atlanta hub, enabling a market share shift from competitors. This was achieved while adding capacity in competitive markets. The total elapsed time to connect to any flight in the hub increased by only 3 minutes (from 74 to 77 minutes) with the tradeoff of higher frequencies for connection times. More importantly, the total elapsed connect time remained at current levels or less for foundation markets. Overall, the hub maintained or improved the connecting times to and from flights as they arrive and depart the hub. The significance of this is that the airline industry experience suggests that the airline with the shortest elapsed time (amount of time it takes to fly from point A to point B) would command the largest revenue share. The Operation Clockwork design achieved this.

Achieving High Reliability within ATC Flow Capacity



Reliability is achieved by smoothing out the peaks and valleys that are common in a traditional banked structure. For an airline, the single greatest driver of high reliability is reducing the planned schedule to levels at or below the Air Traffic Control (ATC) flow rates for an airport. (The ATC flow rate is the number of arrivals and departures that can land and take off in any given hour at an airport).

The hourly flow rate is driven by two factors. The first is ATC flow restrictions in normal and adverse weather. As the weather conditions deteriorate, the number of aircraft that can land and depart is decreased. When ATC flow rates are reduced by weather, delays occur as the allowed flow drops below the planned schedules for the airlines using the airport. These uncontrollable delays can severely disrupt the performance of the schedule and diminish the efficiency of the operation.

Under the traditional banked model for hubs, airlines typically over-schedule during certain periods of the day, even well above the ATC flow capacity even for favorable weather conditions. This is a result of the traditional banked structure and connecting philosophy to capture maximum revenue at the times during the day when stronger traffic demand is forecasted. During the periods when airlines schedule traffic beyond the maximum ATC flow rates, delays occur even on good weather days, and become a nightmare during bad weather. These are self-induced delays that drive inefficiency for the whole industry. Such delays are greatly reduced in the “continuous” operation because the peaks are smoothed out throughout the day.

A continuous hub design coupled with reduced turn times allows an airline schedule to operate well below the maximum ATC flow rate, while maintaining or increasing the total number of flights per day. For example, at the Atlanta hub (prior to the addition of the fifth runway in mid-2006), the ATC flow rate was 92 arrivals and departures per hour on a good weather day and 73 per hour for a poor weather day. The continuous schedule structure has a flow rate demand of 63-69 per hour versus the 88 per hour that Delta had in the traditional banked structure. This capacity tolerance made the operation less susceptible to delays caused by poor weather related reduction in the ATC hourly rate. The continuous schedule flow minimized the impact of ATC flow rate programs, resulting in and overall reduced number and duration of delays.

By successfully designing and implementing the continuous schedule structure, Delta has decreased its dependency upon the uncontrollable variables of ATC flow rates and weather. The airline can now predict and manage variability with more accuracy and control, thus improving performance and consistently deliver higher customer service levels. The enhance efficiency from avoiding irregular operations and peaks for staffing personnel is significant as well.

Other Design Elements for High Reliability

There are a number of other components built into the structure to further manage variability and ensure high levels of performance. They include building the hub schedule structure with over 92% of the flights operating out-and-back. This allows the carrier to isolate any single market during a disruption (*i.e.* weather event), minimizing its impact on the hub and the entire system's performance. A recovery gap for the operation in the hub is provided, creating a "split day" concept, allowing the hub to reset and recover the operation prior to the evening half of the operation. The evening operation is typically the most volatile, driving the majority of performance deteriorations each day.

The Atlanta hub fleet mix (the number of different types of aircraft coming into and out of the hub) was greatly reduced & simplified. Simplifying the number of aircraft types lessened the operational complexity and lowered cost. It also gave the operating groups more options and greater flexibility to recover from irregular operations and disruptions. For example, the airlines Operations Control Center (OCC) can easily change aircraft to regain schedule integrity more quickly, thus reducing delays. The OCC also has greater flexibility to reroute flight crews during irregular operations because of the number of common crew types in the hub is higher with the simpler fleet mix.

The system operational performance and reliability averaged ten points higher for arriving aircraft and fifteen points higher for departing aircraft when the continuous schedule model was first introduced. The new design broke every operational performance record not only for the Atlanta hub but for the entire system. An unanticipated benefit has been lower security checkpoint wait times in Atlanta. These were down by an average of thirty five minutes because originating passengers arrived at the airport in a more regular volume, in synchrony with the new continuous schedule.

Cost Competitiveness

The new continuous schedule design maximized cost savings with the higher system productivity. By eliminating the scheduling peaks and smoothing the capacity throughout the day, the hub absorbed over 80 additional departures per day (with a potential for over 40 more) without adding any resources (headcount or equipment). Productivity improvements were achieved through more efficient scheduling which yielded staffing models with less idle time and overall greater asset utilization of facilities, people, and aircraft. Decreased dependency upon the FAA ATC system resulted in reduced air and ground space congestion, translating to flying time reductions

(time it takes to fly from point A to point B). This in turn drove flight crew staffing efficiency and greater aircraft and airport gate utilization.

In addition, the new design achieved a 3 minute year-over-year improvement in average taxi times (time it takes to depart a gate and become airborne) in the Atlanta hub. The three minutes equates to an additional fifty-two hours per day for the system - or five additional aircraft - that can be re-deployed back into the system to generate revenue.

Excluding fuel, the direct operating cost per available seat mile (DOCASM) decreased with the higher productivity of all assets. Revenue increased as compared to the previous banked structure. To date, the transformation has resulted in hundreds of million dollars in both revenue and cost improvements for the company. Operation Clockwork has set the foundation for Delta's transformation as an industry competitor.

Implementation - Keep The Airline Moving

A new strategy or business model design is often quite elegant, but incredibly difficult to implement internally and with customers. A smooth customer transition was enabled by advanced schedule publication and passenger re-accommodation where necessary. The target implementation date was selected specifically to reduce risk by avoiding peak traffic periods and minimizing passenger impact. Internally, the key to the successful implementation and execution of the new "continuous hub" schedule structure was the ability of the operating groups to sustain the reduced turn times throughout the day. The implementation plan for Operation Clockwork was developed with the involvement of every operating group on a core team that took responsibility for the integration, scheduling, execution and feedback learning from each step.

Transformation of the airline to accommodate this new model focused on four key themes:

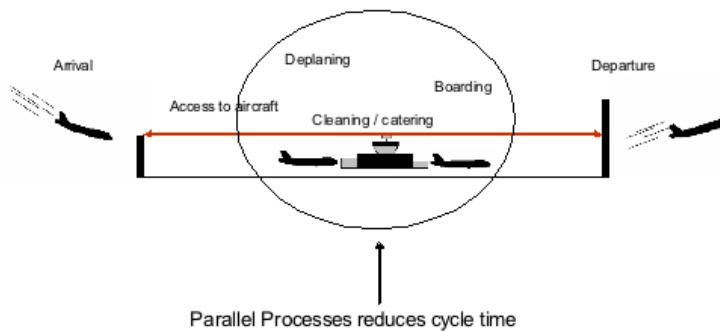
- Turning the Aircraft
- New Operating Philosophy
- Key Focus Areas
- Continuous Improvement

Turning The Aircraft - Right Time, Right Place

When you break down the critical components of the aircraft turn process, there are six key steps:

1. Aircraft arrival and gating. This is critical because the aircraft must reliably and consistently arrive on-time to the airport.
2. Access to the aircraft for service personnel the moment it arrives at the gate with a safe choreography of movement for each part of the ground operation
3. Passenger deplaning in a safe, efficient manner
4. Cleaning and provisioning of the aircraft.
5. Passenger boarding in a safe, efficient manner

6. Aircraft departure from the gate.



This process was traditionally planned and managed as a sequential task flow when there were long turn times between connections. To achieve the desired “continuous hub” turn times, lean manufacturing techniques were applied to reengineer and simultaneously execute as

many tasks as possible. The extra time previously built into the schedule to allow for sequential processing was removed, thus shortening the cycle time between arrival and departure and increasing aircraft utilization.

Achieving a faster aircraft turn capability required a higher level of reliability (delivery of the aircraft to the airport) in conjunction with the airline’s successful implementation of parallel processing of steps two thru five. Each operating group and department became dependent on each other to ensure that the reduced turn could be achieved consistently.

New Operating Philosophy: Everyone Knows What We Are Doing

Picture a clock with its hours, minutes and seconds ticking away:

- The **hour** hand represents the main Operations Control Center (OCC). This group is responsible for managing the entire Network, ensuring that the airline keeps moving reliably while respecting safety as their main objective.
- The **minute** hand represents the station level (airport) personnel who are responsible for ensuring that the number one customer objective of on-time performance is met.
- The **second** hand represents the managers and teams that are responsible for the individual flights. Their objectives - keep the airline moving as efficiently as possible and the assure that the customers are satisfied with the service.

Hours - Keep the airline moving while respecting safety as main objective

- Robust cross-divisional process for departing the aircraft - providing optimal operational control and coordination
- Recover the schedule to normal as quickly as possible (passengers, crews, aircraft, and maintenance).

Minutes - On-Time (departures within zero minutes) - #1 customer requirement

- Customers to destinations on time
- Hold the flight only to fulfill basic service requirements

- Give time back to the schedule as focus for recovering from delayed flights

Seconds - Manage toward zero defects

- Preplan to avoid last minute surprises
- Ensure everything in position to achieve a departure within zero minutes
- Drive accountability throughout the organization and business partners
- Capture and act upon service deficiencies
- Know how to take action to fix problems immediately

Key Focus Areas: Our Safety Net

During Operation Clockwork implementation, the “What Keeps Us Up At Night” list of concerns evolved into a safety net of areas for focus. These have become the building blocks for successful execution of the transformation plan. Because of the interdependency of each block upon the others, when one fails, others would be at risk, and the new business model could not have been successfully implemented. Thus the concept of an interdependent “safety net” was used to assure integrated performance.

Maintain High Reliability

- Build in recovery capabilities directly into the schedule design. Key components are built into the foundation to minimize disruptions and assist in a quicker recovery to the original plan (see reliability section).

Mitigate Cultural Resistance

- Understand the objective: why are we doing this; make it simple and consistent.
- Evolve towards a performance-based culture with emphasis on on-time performance and high efficiency.

Build Sustainability

- Shift from step change to continuous improvement focus.
- Assign responsibility for the fast turn process to a cross-divisional team charged with continuously decreasing turn time while improving service performance.
- Drive performance management across all levels.

Business Partner Performance

- Require continuously better service from our business partners.
- Increase our involvement to help improve operations (cost and effectiveness).
- Establish high levels of accountability with performance-based pay clauses in contracts.

Feedback and Continuous Improvement - Everybody Knows How We Did

After a step change transformation has been achieved, it is imperative to transition into a continuous improvement mode to solidify gained efficiencies and keep pushing towards

operational excellence. There is a need for a holistic view; total optimization versus divisional optimization. Some key components of the change include:

Review Results

- Evaluate transformation achievements against the original objectives, with a focus on new challenges and the desired future state:
 - Operational: process transformation / performance
 - Financial: future financial impact
 - People: mindset and behavior shifts

Communicate Results And Lessons Learned

- Synthesize lessons learned into key themes.
- Communicate and celebrate the transformation phase and achievements.
- Set expectations for continuous improvement.

Continue To Set New Improvement Targets

- Incorporate new targets into the planning and budgeting process.
- Measure and reward the results.

Ensure Success

- Establish a center of operational excellence until transformation becomes part of the culture.
- Develop new objective metrics for new processes.
- Performance reviews at all levels and with business partners.
- Track corrective action and improvement plans.

Conclusion:

On January 31, 2005 Delta implemented the largest Network restructure in the history of aviation called Operation Clockwork. Six billion dollars of revenue generating capacity were moved around in one night. Gerald Grinstein, Delta's CEO, shared his perspective at the annual shareholders meeting in Atlanta on May 19, 2005. *"If you have to put your finger on one thing that could fundamentally change the direction of this airline, it is Operation Clockwork."*

This transformation set the stage for a new business model to achieve the highest possible efficiency and lowest possible cost for the airline. It started a major transformation from a legacy carrier with its high cost structure to a business model that can compete and win in today's battlefield.

There are still many challenges ahead for Delta and the industry. Fuel costs continue to be a huge cost component and barrier to profitability. Bankrupt carriers starved for cash will continue to dilute fares, but will be able to use Chapter 11 provisions to emerge fundamentally and structurally stronger. New low cost carriers (LCC) continue to appear worldwide. In this economic evolution, cost structure is the new battlefield in the airline

industry. The design and implementation of a continuous hub schedule model will enhance throughput in a capacity-constrained network at no additional cost, achieving in the process the simultaneous goals of reducing cost per unit of production and improving product quality. The business models must change or move aside. Ultimately, the ability to maintain the lowest cost while sustaining service and quality will determine the winners and losers. The next downturn is coming.

The airlines must continue to evolve to create a strong, viable and profitable industry. Consolidation is one mechanism that may allow the airline industry to achieve its next phase. It creates capacity rationalization – for a short time. It helps take out weak performing airlines. It resets the playing board. Also, consolidation provides opportunities for innovation. Whether from new entrant carriers that develop innovative ways of driving value to the consumer; or by creating global airlines that transcend international borders, the airline industry will evolve. If managed properly, it can create stronger airlines with magnificent network depth and breadth for serving customers.

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