AIRCRAFT MAINTENANCE PRODUCTION AND INSPECTION: TEAM WORK + EMPOWERMENT + PROCESS SIMPLIFICATION = QUALITY

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What I would like to do is to change our focus a little. So far this morning, the audience has heard about training technicians, mechanics, and inspectors. What I want to present will be familiar to those of you who have gone through TQM-type issues. At United we are learning to think in terms of TQM (Total Quality Management) philosophies and if some of my words sound like buzzwords, I apologize. They are new for us.

What I want to talk about is a management training and learning program that is underway at United. Over the past several years the industry invested considerable time focusing on human factors issues. We have looked closely at the environment: heating, lighting, and issues affecting how an individual works and his or her ability to get at the aircraft and feel safe and comfortable. Another factor that is also critical is an individual's attitude. I am going to focus on attitude today.

Since assuming my position as General Manager of Inspection, I had noticed an increase in friction in our work force over the last several years. My interpretation of the causes of this friction are summarized in **Table 1**. I suspect that everyone recognizes that the aircraft fleets have aged, although newer aircraft are entering operations. The older aircraft certainly have impacted inspectors and mechanics, and how they approach their work. We have seen increases in inspection requirements, Airworthiness Directives, and inspection programs. The newest requirement we are struggling with is the corrosion inspection program. These increased requirements produce additional work for inspectors. Most of these result in increased work cycle times and worker requirements. Another event we have seen at United is a significant increase in the size of the work force. We have newer, younger mechanics and newer, younger inspectors. To give a little perspective, eight or nine years ago, it required twelve to fourteen years seniority as a mechanic to become an Inspector. Today, an inspector can achieve a position with less than five years mechanic seniority. These elements combine to produce lower levels of experience and skill.

Table 1 Observations

- Aircraft Age
- Increased Inspection Requirement (AD's, NDT, Corrosion Program, etc.)
- Increased Manpower Cycle Times
- New/Younger Work Force and Less Dependant on Management
- Reduced Experience and Skill
- Increased Conflict/Tension
  - Lead Mechanics and Inspectors
  - Foremen
  - Mechanics

Routine employee meetings often carried a tone of tension between mechanics and inspectors. Through these meetings and interviews we found that many of the mechanics had a low regard for the aircraft inspector. They criticized the inspector for his perceived lack of skill and his unwillingness to work with mechanics. The mechanics believed the inspector had no "ownership" with the maintenance process. As a result, similar meetings were held with the inspectors. The inspectors were presented with the same questions. The inspectors responded with the same comments about the mechanics and lead mechanics. While conflict is not a new phenomenon in aircraft maintenance ,what I was beginning to see was unique and possibly the beginning of a potential problem.

We began with an aggressive approach to what was going on and to look for opportunities for improvement. The opportunities are summarized as the Process Review in **Table 2**. Four years ago, the Maintenance Division began to move towards TQM. Those of you who have been through TQM know that there is a definite focus on inspection. The idea is to eliminate inspectors and produce quality the first time. As you might imagine in an aircraft maintenance environment this added pressure to the work environment. However, we came through that period and validated the Value-Added role of inspectors. For example, the inspection approach of the past was to insure quality workmanship with inspection. Today, we use the inspector for his ability to evaluate the in-service condition of aircraft structure and when necessary provide a second look or "second set of eyes" for critical installations or system operation. In our environment we are dealing with a maintenance program that requires the skills of detection to identify the defects needing repair. Our inspectors focus these skills on preliminary or shakedown type inspections.

Table 2 Process Review

- Top-Down Directed Implementation of Total Quality Management Philosophies (Best Maintenance)
- Ongoing Process (We have Today's Answers and Tomorrow's Questions)
- Reviewed Organizational Structure of Separation
- Discussions with Lead Mechanics, Inspectors, Foremen, Managers
- Review of Existing Processes (Ongoing)
  Work Relationships between Production-Inspection
  - Separated Maintenance Organizations
  - Job Descriptions/Work Rules
  - FAR Required Separation "121.371" of Production-Inspection
  - Departmental Policies
  - Personalities: Control Types
  - Routine and Non-Routine Work Process
  - Department Goals
    -- Preliminary Inspection Performance
- Reviewed Non-Routine Document Process
  - Developed a Flow Chart of Steps Followed by each Non-Routine
- Experimented with Preliminary Inspection

We are now going through TQM training and TQM roll down to our foremen, and then on down through our inspectors and mechanics. This training is giving us is a new approach for evaluating our business processes and work relationships.

I am going to share some ongoing analysis that we are doing as a result of being critical of our business processes and worker relationships. I have to say that I think I have answers for what is going on today in our process. As we review problems and develop solutions, we discover that there is often an additional answer or another problem (opportunity). The process seems to snowball in terms of looking for new avenues and new approaches to solve problems on the floor. In aircraft inspection we undertook a rather critical organizational review. For those of you who may not know it, within our environment aircraft maintenance and inspection are in a sense two different organizations. I manage the inspection organization, and under the management philosophy taken from the FARs there had been an effort to keep inspectors separated from maintenance. We are finding that this structure creates a very complex work environment that produces turmoil. As I said earlier, we held discussions with our leads and inspectors. We also talked with our foremen. We found many of the work relationships among the foreman were similar to the leads and inspectors. What was apparent throughout all of the discussions was that everyone wanted the work to be done right.

Next, in our aircraft inspection, we began a review of the processes that operated between inspection and production. We focused that review on the relationships between production and inspection. We looked first at the separation of the organizations to understand and determine how valid it is and how it works. We looked at job descriptions and work rules, many of which we found are defined by the FARs, our IAM contract and by the way management has interpreted those definitions over the years.

We took a look at the FAR requirement of separation, §121.371, and at our departmental policies. We evaluated many of the regulations and definitions, placing our emphasis on simplicity. What we typically found was that we had interpreted rigidly and with a much greater requirement of separation than actually exists. When we looked at the people in our process, we discovered that many of our staff have control type personalities, frequently taking control and directing the individual organizations very rigidly. This adds to the friction between inspection and production when they are two separate organizations. The first corrective action we undertook was to reduce the conflict within the management group.

The inspection section managers were released to participate in planning and staffing meetings with the production units. The Inspection Department retained responsibility for the inspection process, overrule decisions and the individual evaluations and job performance issues of the inspection management team. This simple change began the process of combining the inspection and production elements back into aircraft maintenance.

Routine and Non-Routine Work Processes

The next process to be reviewed was the method of communicating non-routine maintenance. The inspection managers developed a process flow chart to trace the movements of the non- routine document and the way we identify non-routine work. Much of this process is a problem when you have a separated maintenance organization. We historically worked hard at keeping the inspector and the mechanic away from each other. Over the years we took the philosophy of separation in support of the FAR requirement and carried it into a separation of talent and skill that created a sense of conflict. When we developed the flow chart and made a presentation of our non-routine work process, it quickly became referred to as the great Easter egg hunt. The process works this way: an aircraft inspector would be assigned to accomplish a preliminary inspection of the aircraft, and he would report defects on single sheets of paper (non-routines). He would then turn the paper over to the planning center. The document would go to a lead mechanic, and the lead mechanic, under our system, will determine the corrective action to fix the defect.

The lead retraces the inspectors steps to locate the defect, spending time searching, identifying it, and determining what corrective action is necessary. The lead then processes the non-routine simply by saying what to do; it could be anything from simply changing a tire or brake to accomplishing a major structural repair. The lead's work then would go back to the planning center and then finally to a mechanic. The mechanic comes in as the third player in this process and must locate the defect again, figure out what to do, obtain all the documentation, obtain all the tooling and then probably would have to find the lead mechanic for additional information. This process requires a protracted period of time. Finally, after the mechanic does in fact get the defect corrected, the inspector, who has been kept out of the process is now brought back to evaluate the correctness of the repair. Because we have variable staffing and manpower to keep the work flow and work force somewhat steady, this is probably not the same inspector who wrote up the defect initially.

Now a fourth person is in the picture who does not have the advantage of ever having seen the defect. This final inspector has to determine if this is the defect area and repaired or a brand new part that was replaced. One can picture a repair that has obviously been repaired, but it is not quite so easy when a component has been completely replaced and the inspector can only assume that the work accomplished and the non-routine match up. So this is what has come to be called our great Easter egg hunt, the non-routine process.

Conflicting department goals are another process we have. Even though we kept telling ourselves that inspection and production plan and organize their work and their operations very much the same, they were separate departments with different goals. Together we did not understand the impact of some of the goals that we had, and we still do not understand them all. I think what I will show you shortly is a little of what we saw in the way of how our goals affect each other.

We reviewed the non-routine process that I have described and then we began to experiment with our preliminary inspection (**Table 3**). This is the issue of goals that I just talked about. For example, we had a time line to complete the aircraft maintenance visit in the hangar and to return the aircraft back to service. It is a business practice. We do not want an aircraft sitting in the hangar for a long time. It certainly does not generate any revenue during maintenance, so the idea is to get the inspection done, to identify all the defects, repair the defects in the shortest amount of time, and release the aircraft. We thought, and some of us still think, that the preliminary inspection is the critical path for completing the aircraft. The method used by inspection to accomplish this is to increase the staff and complete the inspection as fast as possible. We experimented just a bit to see what would happen if we altered the preliminary schedule. In one event, we increased the inspection staff to speed up the preliminary to get it done faster. The aircraft visit was completed in the same amount of hanger time. Next, we went back and reduced the preliminary staffing allowing the preliminary to drag on, while keeping a focus on the planned aircraft release date. The aircraft was released to service in the same amount of time.

Table 3 The Experiment

- Clearly Defined the Mission of Aircraft Maintenance:
  "Maintain Aircraft Better than Anyone Else"
- Defined Aircraft Maintenance as a Combined Inspection-Production Activity
- Assigned Inspection Management to Attend the Production Organization Meetings
- Selected Work Centers (Dock 4-SFO B737 HMV and Bay 1,3OAK B747 & DC 10 BCP)
- Created Lead/Inspector Teams
- Fixed Versus Variable Assignment of Inspectors
- Redefined Preliminary
  - Find Most Significant Defects Early
  - Routine Preliminary Accomplished within First 1/3 of Aircraft Visit
- Mechanic Given Expectation of Personal Responsibility for Quality

We now questioned whether or not there was any real validity to rushing through the preliminary. We knew we had conflict growing between inspectors and lead mechanics. We also knew that we had a complex non-routine system.

Now that we had several theories about our processes, the next step was to lay out an experiment. Within our organization I began to refer to the operation as aircraft maintenance, combining inspection and production activities. We are trying to get our people away from talking to each other in terms of inspection and production but simply to talk as aircraft maintenance professionals. Within my own management staff, I directed the inspection managers to attend and participate with production management so that they are, in a real sense, in direct communication with their counterparts. We also traded foremen between the inspection and production organizations.

Working with our heavy maintenance managers, we selected several work centers for the experiment. The first, Dock 4, accomplishes 737 HMV's in San Francisco. This dock was selected because of its consistent work type and because the dock is often used to provide manpower to other work centers. We thought that the 737 HMV was an ideal choice for the experiment since the mechanics have the same desire to complete the aircraft on time as everybody else. But they always feel that they are impeded because they become a manpower pool for the wide body fleet. In Oakland, the DC-10 and the 747 heavy checks were selected. In Oakland the work is performed in Bay 1 and Bay 3.

The next step was to create focus groups (TEAMS). This is a little different from the way we would have had it in the past, which was with variable staffing and isolated inspectors. We created lead/ inspector teams that would remain with the aircraft through the entire visit, working together and developing their plans together. The inspector was also expected to remain in the work area, providing help and coaching the mechanics while repairs were in progress. The lead/inspector teams were assigned for the duration of the aircraft visit and responsible for all the work accomplished in specific zones of the aircraft. Instead of the inspectors accomplishing a rush-type preliminary with 15-20 inspectors on the aircraft at a time, we reduced the staffing to five inspectors. We allowed them to stay there for the full length of the visit rather than staying for a couple of days, during the preliminary, and then going to another dock, leaving just one or two inspectors to finish up. The fixed and variable assignment offers some interesting opportunities that we did not anticipate.

In addition to the pace of the preliminary we asked the team to locate and identify the significant defects early. Over the years, we have learned that our leads and inspectors that have worked with an aircraft know what to expect to be wrong before the aircraft arrives. They know what they can anticipate in the way of heavy work. We asked them, rather than to spend their time on the rigors of a focused preliminary, use your experience and identify the defects that have a high probability of occurring. We wanted those reported early to gain the greatest possible lead time for repair. We wanted to complete the preliminary within the first 1/3 of the aircraft visit to keep pace with the expected aircraft release date. In the past, we would have said that we wanted the preliminary done in the first 12 shifts. The experiment was set up to reduce the pressure of schedule on the preliminary. We said it was appropriate to take the preliminary out to 18 or 21 shifts and not to worry about it as long as the major defects were found early. Then, go back through all the standard work patterns to ensure that the preliminary inspection requirements were accomplished.

The last thing we did was to tell the mechanics that they are responsible for quality. Over the years, United's focus on inspection has grown so that today at the Maintenance Base we have 100% inspection Buy Back of every task accomplished by a mechanic. The inspector is asked to accept too much responsibility and the mechanic is willing to transfer his responsibility to the inspector. It is not unusual to hear a mechanic say, "If the inspector buys it, it must be O.K." Statements like this from the mechanic cause the inspector to lose his confidence in the mechanic and become far too critical of the work performed (remember the conflict I mentioned). This also defeats the second set of eyes concept since the mechanic is essentially transferring his responsibility to the inspector. The mechanic has ceased to be the first element in the Quality Control Process. This is why we went back to the mechanics and reinforced that quality is their responsibility.

Table 4 lists some of our expectations. The process simplification is certainly the non-routine. We are still working to simplify that process. However, teaming the inspectors with the lead mechanics on the dock certainly does reduce some of the hand-off and the communications breakdowns resulting from having separated and variable staffing. Having the leads and inspectors working together as a team reduces some of the communications breakdowns and misunderstandings they were having. We believe that we are seeing an increase in their knowledge of each other's responsibility and, as a result, an increase in the respect they have for each other. Lately, we are seeing a significant reduction in conflict. To better explain that, I conducted several focus meetings with various groups of mechanics, leads and inspectors that were working on the docks. One of the things that I used to finish my presentation was that a year ago we were seeing conflict and frustration between inspectors and leads. One of the leads rebutted my comment with "We don't have any conflicts." He then went through a long litany of how they work together, how they discuss their problems, and solve problems without involving management. I thought that was pretty good. I kept quiet, sat back, and said, "Great, I think we're heading in the right direction." Because the leads were saying something completely different the year before.

Table 4 Expectations

- Process Simplification
  - Non-routine Document Process
  - Simplified Communications between Lead and Inspector
  - Increased Knowledge of Each Other's Responsibility
  - Reduced Conflict Caused by Separation
- Empowerment
  - Decisions Being Made Jointly with Leads/Inspectors
  - Reduced Management Control of the Process
- Information Access
  - Inspector is Available for Consultation with Mechanics/Leads
  - Eliminates "After-the-Fact" Decisions by the Inspector
- People Development
  - Inspector can Train and Coach Mechanics
  - New Inspectors have Opportunity to Learn from Experienced Leads/Mechanics
- Future Focus
  - Continue Moving the Inspector into the Process

We continue to struggle with empowerment. We are not certain where we are going with empowerment, but we are trying to move some decision-making down to leads, inspectors, and mechanics. We had forgotten that our mechanics are trained, qualified and licensed. What we find when we look at our processes with simplification and empowerment in mind is that we have built considerable control into our system and reduced the authority and responsibility of the mechanic. Generally, we have some rule that a foreman must be involved and make the decision. We are now trying to push decisions down to lead mechanics and to allow them to use their authority and training and getting management out of micromanaging the process.

Information access is another issue with us, as well as probably everywhere else. In this case, I am referring to the information between the inspector and the lead. Keeping the inspector on the dock allows for close communication. A lead having a problem with a write-up knows who wrote it enabling him to get quick resolution. The mechanic can do the same.

We also are interested in developing our people. We find that the inspector, who receives considerable training, has an opportunity to train and coach the newer mechanics, providing them with the guidance they need to achieve. We focused on providing classroom opportunities where we present the same material over and over again. An individual needs someone to reinforce that learning, somebody to troubleshoot with, somebody to bounce ideas off. We had success with these ideas in our NDT operation when inspectors were teamed together. Now, we are trying to move it into the general maintenance community, having the inspector and the lead who have the training start to roll it down to the mechanic. Keeping the crew and team together allows training and learning to occur.

We saw the same thing happen with the new inspectors. Where we have new inspectors who are allowed to work with the senior inspector, they have a much higher confidence level and become independent much faster. After we looked at the separation of leads and inspectors and saw the conflict, we knew that mutual learning between leads and inspectors was not occurring. In the areas where we experimented by putting the inspector on a team permanently, communication significantly increased and we could see the mutual training and learning beginning.

In terms of where we are going to go with these ideas, I like the idea of putting the inspector in the process so much that we are continuing to do that. We see the inspector and the lead as the leaders in the hangar. They have the expertise; they have the experience. We are seeing that they also can provide leadership if we let them.

Table 5 offers a quick summary of what was observed.

Table 5 Results

Dock 4:

- Minor Increase in Cycle Time for Preliminary Inspection
- Increased Number of Non-Routines
- Reduced Number of Post-Visit Test Flights
- Slight Improvement in Aircraft MSR over Previous HMVs

Bay 3:

- First Aircraft to be Released Ahead of Schedule
- Significantly Improved Relationships among Inspectors, Leads, and Mechanics

General

- All Personnel Expressed Satisfaction with the Process
- Provided Increased Time for Lead Mechanics to Lead Work Force and Direct Aircraft Operations
- Significantly Reduced Conflicts between Leads-Inspectors
- Leads become Supportive of Inspectors

In Dock 4, the first item is a minor increase in the cycle time for the preliminary inspection. I was initially anticipating a preliminary goal as half the length of the aircraft visit; what we saw was an increase of only three or four shifts, not a significant change. However, we did see something that causes some anxiety: a significant number of non-routine documents were generated. We did four aircraft in Dock 4 and each aircraft increased over the previous one in terms of non-routine. The last aircraft completed with over 3,900 non-routine documents; typically, we would anticipate 2,500-2,800 non-routines.

On the positive side, we also saw a reduced number of post-visit test flights. Those of you who are familiar with our operation know that our aircraft coming out of heavy check receive a full flight test by our engineering flight test crew. For the last 737 that Dock 4 returned to service, the aircraft flew a single test flight with only one non-routine for a coffeemaker, of all things. We have a significant payback because it is rather expensive to do a test flight and then bring an aircraft back for additional work.

We are tracking the four aircraft through their operational cycle, and we are seeing a slight improvement in the airplanes' operating performance. In this case, I am referring to the MSR. For those of you familiar with the mechanical schedule reliability, those four airplanes seem to be slightly better than aircraft previously released from Dock 4 in terms of delays and cancellations. In Bay 3, the aircraft released in Oakland was one of the first that was released ahead of schedule. The first airplane on which we put the inspectors and leads together as a team was also the first aircraft that released to service ahead of schedule.

We have seen a significant improvement in relationships among inspectors, leads, mechanics and management. The reduction in turmoil is improving the cycle and the process considerably; certainly, it adds to our training and to the understanding each has of their responsibilities and their roles.

These are some of the comments I heard when we debriefed our people on how they saw this process. I think everyone basically expressed satisfaction with the process. The leads liked having the same inspector to work with through the entire visit. One of the features that came from the change in the preliminary was more freedom for the lead mechanic. A diligent inspector rushing to complete the preliminary can inundate the lead with paperwork. Keep in mind that in our process the inspector is not allowed to tell maintenance how to fix the airplane, he works in that other organization. An inspector is only allowed to say what is wrong. Maintenance wants to determine how to fix it, and that is the lead mechanic's role. At the same time, a lead is also directing people, directing the work on the airplane, and trying to keep the entire process going during its early stages in the hangar. We found that by stretching out the preliminary, leads were not inundated with paperwork, and, as a result, the lead did not need to create more lead mechanics to do the work. When we debriefed the lead as to what they had been doing in the past, we found that they were upgrading mechanics to be lead mechanics during the preliminary so they could keep up with the work and, at the same time, keep all the paperwork flowing. We gained rather significantly here.

I have talked a lot about the conflicts between leads and inspectors. In summary, what we are observing is that much of this conflict is caused by processes. When the groups work as TEAMS they are capable of reducing the conflict caused by complex processes. I believe what we are seeing is that the way we manage is impacting our work force with rules and requirements that set the stage for conflicts. The leads and inspectors in these experiments became supportive of each other in the hangars, and were overall very pleased with what they were doing. These are a few of the changes we made to evaluate our processes. We by no means have them fully implemented in San Francisco or Oakland, we still have not convinced our personnel that leads and inspectors are talented and can be expected to do good quality work in a cost effective manner. But, we are moving in a direction that will empower the technicians to use their skills to produce a QUALITY PRODUCT at the LEAST COST.

In March of 1994 we are opening up United's Maintenance Center in Indianapolis. All of what I have discussed here will be implemented directly into the Indianapolis operation. The lead and inspector will be on the same team, the inspector will also determine corrective action and many routine checks or inspections will be delegated to the mechanic to find and fix. Thank You.