

January 2010

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Like many MRO centers, Corpus Christi Army Depot employs lean and Six Sigma. But it also adopted a management tool that has it enter the world of WIP, buffers and the theory of constraint.

A steady drumbeat of battle-damaged helicopters, like the H-60 shown here, comes to Corpus Christi Army Depot for repairs, maintenance and upgrades.

How CCAD Tackled A Growing Workload

By David Jensen

About a year ago, the Corpus Christi Army Depot (CCAD) faced a dilemma. A steady flow of battle-damaged helicopters was coming in for refurbishment and overhaul from Iraq and Afghanistan, and the center was tasked to carry out two major Sikorsky H-60 upgrade programs. The workload was expanding but not the resources.

CCAD leadership had to determine how to do more with less. They had adopted "lean" and Six Sigma, which delivered local gains in segments of the aircraft refurbishment process—for example, in the paint department. But these measures didn't provide the global benefits needed.

Almost coincidentally, San Jose, Calif.-based Realization, a consulting firm in project management, made a sales call at the depot. "Their timing was fortuitous," says George Kunkle III, CCAD's process optimization manager.

Depot management was immediately sold on Realization's proposal.

In its ongoing effort to improve efficiency, CCAD inadvertently implemented some procedures Realization was proposing. "We knew when they laid out their plan that we would receive results rather quickly," he told *Rotor & Wing*.

In early 2009, CCAD began incorporating the Realization principles and using a management tool called Concerto. Depot officials were correct; positive results soon followed. Throughput for one of the high-density H-60 pulse lines increased by 40 percent, and for the

low-density Chinook, cross service (Navy, Air Force) and Apache lines, average turnaround (cycle) time was reduced by 15 to 25 percent.

Kunkle touted CCAD's success at Realization's annual Project Flow Conference in San Francisco. Like at a Weight Watchers conference, representatives from companies in areas ranging from mining and concrete to satellite development (Boeing) got up to tell how much they had lost. Only instead of pounds of weight, the speakers talked of shedding waste in their production. (Of note, a case study also was presented by representatives of Army Fleet Support LLC, a subsidiary of L-3 Communications Integrated Systems that provides maintenance and logistical support for the more than 500 Army helicopters stationed at Fort Rucker, Ala.)

From his conference presentation and subsequent conversations with Kunkle, *Rotor & Wing* learned the scope of CCAD's mission, its goals and what it has done to achieve them.

Golden Anniversary

CCAD (Aviation) is one of two U.S. Army Aviation/Missile depots; the other one is Air Defense/Tactical Missile Systems in Letterkenny, Pa. Both are under Aviation and Missile Command (AMCOM).

CCAD also is the largest tenant of Naval Air Station Corpus Christi, a sprawling 20,000-acre complex established in 1941 as a flight-training center. Former President George H.W. Bush happened to be its youngest pilot-training

graduate. Once the world's largest pilot training facility, Corpus Christi is home for five training air wings, 16 training squadrons and the workplace for more than 14,000 Navy and civilian personnel.

Corpus Christi is an ideal hub to deliver helicopters from around the world. It is located next to the United States' sixth largest deep-water port and has three large runways on an all-weather, 24-hour airfield.

The Corpus Christi Army Depot celebrates its 50th anniversary in 2011. Its rich heritage includes an impressive array of figures: by the end of 2008, more than 14,200 refurbished aircraft, close to 70,500 overhauled engines and 1.72 million rebuilt parts and components.

Of course, a long-running government agency also can have entrenched a rigid environment that tends to resist significant change, such as proposed by Realization. "One of the toughest things to do is to get the customers to buy in on the process," says Kunkle. In this case, the customers are Army and Air Force program offices/managers in charge of individual helicopter types.

Occupying six aircraft hangars and more than 100 production shops, CCAD's principal responsibility is repairing and overhauling the Army's UH-60 Black Hawk, AH-64 Apache and CH-47 Chinook. It also has been assigned the U.S. Air Force's HH/MH-60 Pave Hawk, and it still repairs and overhauls UH-1Ns for the Air Force and U.S. Navy. "We complete about four to six UH-1s a year," says Kunkle.

The Corpus Christi Army Depot is that region's largest single industrial employer with a workforce of more than 4,000 (plus 1,000 contractors) occupying approximately 50 buildings.

CCAD performs some "pilot" overhaul programs for the Bell OH-58 Kiowa but hopes to take on more extensive refurbishment programs of this type. "They are also in need of a recap program, as well as crash and battle damage repair," says Kunkle, regarding the Army's fleet of single-engine, reconnaissance and fire-support helicopters. "Those aircraft are used pretty hard in theater."

All told, according CCAD's commander Col. Joe Dunaway, the depot has 1,400 active programs, ranging from component overhaul to aircraft refurbishment and upgrades.

The Army depot is the region's largest single industrial employer with a workforce of more than 4,000 (plus 1,000 contractors) occupying approximately 50 buildings, including one as long as a city block that houses more than 100 process and production support facilities. In addition to repair and overhaul, the depot also has production capabilities that include extensive machining, fabrication and computer-aided design and manufacturing.

These capabilities no doubt contributed to a distinction CCAD gained in 2008 when it was assigned the UH-60 A-to-L recapitalization, or "recap," program. "This is the first time in history that a depot has been authorized to upgrade an aircraft," Kunkle boasts. "Instead of the Army buying all-new aircraft from the manufacturer, we modify older A-model Black Hawk airframes [with a new gearbox, T700-GE-701D turboshaft engines and updated flight control system], and we provide a like-new, latest-configuration/model aircraft."

The first recap UH-60L rolled out of the depot in June 2009. "The Army plans to recapitalize more than 400 UH-60A Black Hawk helicopters," according to an Army release.

The UH-60 recap helicopters, which are sequenced in with the battle-damaged aircraft, increased CCAD's workload. However, with its new project manage-



ment procedures, the depot was able to increase the recap line's weekly throughput by 40 percent. Aircraft assembly alone was once reduced from 60 days to 21 days.

"We met our one-aircraft-per-week goal," says Kunkle. "We now are capable of completing more Black Hawks per year than before the new procedures."

The manager believes the Black Hawk upgrade could open doors to future recap programs of other helicopter types. In fact, he adds, CCAD took on a task "that virtually matches the UH-60 recap" last year when it assumed the structural improvement program (SIP) for the Air Force's Pave Hawk. The service operates about 100 HH/MH-60s in personnel insertion and search-and-rescue missions.

In this case, the depot's goal is to complete a SIP helicopter in the same amount of time it has taken to complete a helicopter in joint depot-level maintenance (JDLM). "We're not quite there yet," Kunkle admits. "We're about a year away from matching the best JDLM."

CCAD plays a different role with the AH-64 Apache, also being updated. "We overhaul the airframe, then send the shell [airframe] along with new or overhauled components to Boeing for update from an A model to a D model," says Kunkle. Premodification time on the Apache has been reduced by 50 percent thanks to new project management procedures, and the number of aircraft delivered yearly has more than doubled.

Hunting Down Constraint

How has the Corpus Christi depot improved throughput and cycle times? And where do its officials gain their confidence in meeting production goals, especially given the uncertainties when refurbishing battle-damaged helicopters? In large part, they attribute a combination of lean/Six Sigma and critical chain project management (CCPM), the program Realization proposed.

Based on the theory of constraints advanced by Realization's Dr. Eliyahu Goldratt, CCPM holds that, contrary to popular belief, uncertainties often do not bring about a production or maintenance facility's poor performance. Poor management practices do.

CCPM is based on the premise that when faced with uncertainties and tight deadlines, management tends to start projects as soon as possible (ASAP). Therefore, a lot of work is started, increasing the competition for limited resources. Multitasking (moving from one task to another) takes place, which has personnel spread thin, causing inefficiency. This, in turn, worsens delays that create even more pressure to start ASAP. It becomes a vicious cycle.

Such a situation existed at the Corpus Christi depot. "In one form or another, we were working on as many as 70 aircraft at a time," Kunkle admits. "We were probably the poster child in multitasking and changing priorities."

"All this lead to desynchronization,"



he adds. "With the complex processes we work on, too often the right hand didn't know what the left hand was doing."

The depot's first step when applying CCPM was to reduce the work in process (WIP). "The idea is to filter resources off aircraft we shouldn't be working on and on to aircraft we should be working on," Kunkle explains. "You work on fewer aircraft at a time."

The depot "froze" the work on some helicopters, i.e., parked them, which was not popular among the program managers, customers and division chiefs, each of whom wants to see the helicopter type he manages receive immediate attention.

Admitting that working on fewer aircraft simultaneously may seem "counter-intuitive," Kunkle says WIP reduction improved throughput "right away," thus quickly abating the division chiefs' worry that their aircraft would not be completed promptly.

To instill more global thinking, depot management wanted to break down the "stove pipe" mentality and have division chiefs work cooperatively as members of the core team established to implement CCPM. Felix Tagle, the Chinook division chief is the core team leader. As members of the team, Tagle and the other division heads must now take a global view of the depot's operations and not concentrate just on their own area of responsibility.

Not a Matter of Manhours

At the same time, Corpus Christi depot personnel changed the way they measured

project performance. Instead of being measured in manhours—"which doesn't translate into production," says Kunkle—efficiency is measured in throughput, on-time deliveries and task completions daily.

And no longer could production controllers/managers inflate or continually alter their estimated times to complete a job, a throwback to when they were graded on manhours. Where CCPM was applied at the depot, cycle times were simply slashed by one-fourth.

"We just cut better than 25 percent of that time [estimated to complete a job] off the historical average," says Kunkle. Hard dates are set, but only for a project's start and completion. They are not set for individual tasks or processes, which is key to CCPM. However, one-third of the set cycle time is added as a "buffer."

The emphasis now shifts from increasing manhours for a project to controlling the buffer and pushing throughput on a global scale. "And if one maintenance program has a delay, we will look at another aircraft that may have been scheduled to sell at a later date, and we'll move it ahead to meet the two-aircraft-per-week goal and also reduce manhours," says Kunkle. The aim is to use as little of the buffer as possible.

Throughout the Project Flow Conference in San Francisco, speakers were accordant in stressing "buffer management," which means having a project completed well within the set cycle time.

The Concerto software facilitates buffer management by first breaking down a

Critical chain project management (CCPM) stresses poor performance is due to poor management practices, not unknowns. Although counter-intuitive, reducing work in progress (WIP) was key to improving throughput at CCAD.

maintenance project into assessable tasks that can be monitored to check for bottlenecks. When a bottleneck is detected, an "issue resolution team" is quickly dispatched to direct all available resources to rectify the task, gobbling up buffer. This team comprises "subject matter experts who are self-starters and motivators from every discipline or area," says Kunkle. "They are, for example, quality, safety, programs, engineering/process engineers." Often they apply lean/Six Sigma principles to tackle the delay.

So intent is buffer management at the Corpus Christi depot that a resolution to a bottleneck may even draw resources from another aircraft being worked on. The Concerto software assists by offering task priorities on a global level.

In addition to the issue resolution team and core team, the Corpus Christi depot established a steering committee, which includes the heads of five maintenance directorates: airframes, components, quality, production management and resource management. Col. Dunaway, Kunkle, Kunkle's boss, Dennis Williamson, deputy commander for maintenance operations, and the heads of four resource directorates also are on the steering committee.

Meeting once a week, the committee views the progress of critical chain procedures from a big-picture vantage point. Its members discuss "action items," i.e., inhibitors to throughput that require resolution at the executive level.

"We used to discuss 30 or 40 action items each meeting," says Kunkle. "Now it's down to three or four." Steering committee members also walk through the hangar to make sure WIP is under control and people are working on projects they should be working on.

The depot started CCPM in the airframe directorate, where each helicopter airframe is cleaned, disassembled, prepared for pre-shop analysis and assembled. Depot personnel were apprehensive about launching critical chain procedures in such a complex directorate—one that

CCPM has helped Corpus Christi Army Depot improve throughput from 1.4 to 1.75 aircraft per week. Their goal: two aircraft per week.

calls for support from almost all component areas.

But they reckoned that the component overhaul directorate, with its more than 100 shops (for flight controls, avionics, welding, machining, hydraulics, rotor blades, bearing overhaul, etc.), would be even more complex. Seventy-five percent of the depot's workload is component work in the back shops. The airframe directorate thus became the launch section "with no regrets," Kunkle affirms.

Full Kitting

Full kitting also contributed to greater efficiency at CCAD. In this case, a kit is more than parts and manuals; it comprises all resources, including personnel, to complete an assembly on time. Depot management incorporated full kitting into the Concerto tool to, again, detect bottlenecks.

"Using full kitting has created focus in different areas," says Don Dawson, full kit manager. "We are able to concentrate on fewer aircraft and on all our supporting entities to take care of those aircraft, and therefore reduce workload."

Instead of working on almost 1,700 parts per aircraft and multitasking up to 80 different helicopters at a time, the



schedulers and production controllers, with their limited resources, concentrate on the 12 "lead" aircraft and getting full kits up to 95 percent by execution time, he explains.

For full kitting, the depot developed new spreadsheets and established two full-kit points, one for the "structures" phase of helicopter refurbishment and one for the assembly phase. The structures phase, or airframe repair, is the depot's biggest job. It also is unique to the Corpus Christi depot, involving laser techniques for airframe alignment and the manufacturing of unavailable parts—tasks even the original equipment manufacturers don't do.

Parts are routed to one or all of the depot's 100 different component shops and numerous staging areas, and each one may undergo several stops at process shops, such as for plating, heat-treating, painting, etc. To assure all parts are available when needed, therefore, the kit provider must physically hand off the parts to the project manager, who in turn "signs off" the parts. This hand-off is done a week in advance, giving the project manager sufficient time for the sign off.

The Future

Starting in late September, Corpus Christi depot contracted Realization to begin introducing CCPM to the back shops and other directorates. The need to improve parts overhaul throughput

is critical, according to Williamson, because work on the aircraft pulse line was "getting ahead" of parts availability. Also, Kunkle stresses, the component programs are critical to the war-support effort.

Depot personnel are pleased with their progress with CCPM, but expect even better results. CCAD saw overall throughput jump from 1.4 to 1.75 aircraft per week soon after it reduced WIP, and management is confident it can reach its goal of two aircraft weekly, or 120 a year. "We plan to meet that goal next year, as long as the customer is funded to provide that many aircraft or we get new workload from other sources to fill our excess capacity," says Kunkle.

He estimates, however, that Congress will fund work on only 100 helicopters. "If that's the case, we'll look for more business," Kunkle adds, indicating the OH-58 would be prime to pursue. He foresees the depot soon having more capacity than aircraft to maintain. ✈

Critical Chain Rules

Critical chain project management follows three basic rules. At first blush they would seem to make common sense. Yet, surprisingly, many businesses and agencies not only don't follow the rules, they take an opposite approach. The rules are:

- Limit the number of projects in execution. Instead of starting projects ASAP, stagger them.
- Don't turn local task-level estimates into commitments. Instead of hidden "safeties" with tasks, create aggressive project plans with global buffer.
- Synchronize execution of priorities. Give highest priority to tasks that are consuming the most buffer.

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