MISSION PLANNING ADVANCES FOR THE PAVEHAWK HELICOPTER

Ricky K. Westray
Software Engineering Division
Robins Air Force Base, GA, USA

Abstract

The need for a Combat Search and Rescue (CSAR) capabilities is gaining in importance. Every military planning option the United States military considers requires a CSAR component. Recovery of downed personnel is important because the United States values the lives of each of its soldiers. Today's soldiers also carry much more expertise and military intelligence into battle. Recovering a downed soldier retains this expertise and prevents sensitive intelligence from falling into the hands of the enemy. This paper discusses the improvements made to the HH-60G Pave Hawk the primary CSAR helicopter for all U.S. Air Force missions.

An effective CSAR capability requires more than merely owning a helicopter. Having good CSAR capabilities requires an aircraft that can penetrate hostile territory covertly, at night and in adverse weather conditions. The aircraft and the crew must be able to respond in a short amount of time to critical mission needs. The Pave Hawk and the crews that serve them fill all these requirements and more. The H-60 airframe is rugged and the Pave Hawk has enough enhancements to allow it to fly anywhere, anytime in any weather conditions. It is imperative, especially in hostile territory, for the CSAR aircraft to reach the recovery site as quickly as possible. Rescue crews are not afforded the luxury of flying around a general area looking for a crash site. To get in and out as quickly as possible requires a precise navigation system. The Pave Hawk possesses one of the most sophisticated and accurate navigation systems in the world.

To respond rapidly to a need and to carry out the mission safely and successfully requires an automated mission planning system. This system will develop a flight plan in an office environment while the flight crews are physically preparing the aircraft and themselves for the mission. The flight plan, or mission plan, can then be electronically downloaded into the aircraft navigation system. This mission plan takes into account terrain, weather conditions and aircraft flight performance in developing the proper route to take. The mission plan also provides intelligence data relating to known threats and what kind they are as well as performing fuel and time to target calculations. The United States Air Force, including the Pave Hawk, uses the Portable Flight Planning System (PFPS) as its mission planning system. PFPS is the core system common across all weapon systems. This allows intelligence and other mission planning data to be uniformly distributed to all units participating in a particular military operation. Each weapon system in turn uses its own unique component with PFPS to develop a tailored mission plan. This unique component is called an Aircraft/Weapons/Electronics (AWE) module. Each aircraft AWE contains flight performance data as well as other parameters unique to that aircraft. The Pave Hawk AWE has made significant advances in providing the aircrews with information needed to allow them to perform their duties better than anyone else in the CSAR field. This paper will discuss those advances and the software support activities responsible for those advances.

The Software Engineering Division on Robins Air Force Base is responsible for supporting the Pave Hawk AWE. This requires attaining knowledge of the Pave Hawk aircraft and its mission as well as working with the aircrews to determine how the AWE can be modified to give them the best opportunities for success. Rapid implementation of software changes ensures that the aircrews receive enhanced capabilities as soon as possible. This paper will discuss the issues involved with supporting the current mission planning system.

Introduction

Military operations are, as a rule, perilous and uncertain. Loss of personnel and equipment is an unavoidable risk when the use of force is used to resolve conflicts between nations and sometimes within nations. The enemy usually does not act as predicted and there are numerous other variables that are beyond the direct control of armed services personnel. Even in the best of campaigns, men and women, both military and civilian, often find themselves isolated in enemy held territory or in remote regions where they are unable to safely return to the main force. Recovery of downed personnel and the military assets with them is becoming increasingly more important to the military strategy of the United States. It is the sole responsible of The Combat Search And Rescue (CSAR) forces to retrieve downed soldiers and civilians from dangerous locations. The United States Department of Defense is devoting more and more resources to this element of the United States armed forces [1].

There are several reasons for making CSAR operations a vital component of military operations. First and foremost, the United States values the life of its soldiers. They are sent into to harms way defending our liberties. They are willing to die to make the world a better place. The least that can be done for these soldiers is to save as many of them as possible. A strong CSAR force also increases morale, which leads to an increase in performance by military personnel. Many believe this to be greatest benefit of CSAR operations. Recruiting is enhanced if young men and women know that the armed services will look out for their interest and do their best to bring them home safely.

CSAR operations are also necessary for tactical reasons. The loss of soldiers, for any reason, means a loss in force strength. This loss can be counted in numbers, the amount of troops available for combat, as well as in combat readiness. Soldiers lost in combat may be replaced but they must be trained. However, no amount of training can be an adequate substitute for experience. In the summer of 1940, during the height of the Battle for Britain, the Royal Air Force lost 450 men in six weeks. Only 260 new replacements could be found, and most of those had no experience and had not yet completed their training [2]. Loss of experienced personnel adds risks to future operations. If experienced personnel can be recovered and returned to duty, then operational strength is maintained and even enhanced as downed soldiers bring back more hard earned lessons learned.

Recovery of downed personnel also prevents the loss of sensitive tactical or even strategic information. Captured personnel may be induced to provide their knowledge of current operations to the enemy. It is likely that even the strongest soldiers will give away some amount of information. Even if the downed soldiers can withstand the pressures to talk, the enemy can gain valuable information by learning the origin and makeup of the captured troops. Throughout history, major operations have been compromised and have failed due to intelligence gained from captured soldiers. As much as everyone wants to believe in the toughness of their soldiers, the reality is that they are human and do have a breaking point. The more downed personnel that are captured, the more likely that tactical plans will be compromised. A downed soldier may reveal information that, alone, does not tell the enemy very much. It is a small piece of a very large puzzle. However, as the number of captured soldiers increases, so does the amount of information. A large number of small pieces of information can be linked together to give yield an accurate picture of current operations and strategy. Therefore, the more downed personnel that can be recovered means less risk revealing sensitive plans and information to the enemy.

Captured personnel are often exploited for propaganda and political value. The political cost of losing downed personnel must not be underestimated. The loss of lives and the harsh treatment of captured personnel reduce public support for military actions. The loss of personnel has always been a reality of war but current technology now brings these losses into the living rooms of the civilians back home. When shocking images of battle or the treatment of prisoners is viewed on the television, when brutal realities of warfare are revealed and brought home in living color, the public reconsiders its support for these operations.

The United Nations humanitarian mission to Somalia illustrates this point well. Initially a non-combat mission, several incidents lead to a military operation to capture the Somali warlord Aidid. A battle ensued in which eighteen American soldiers died and seventy-seven were wounded. Immediately afterwards the world saw graphic images of dead servicemen being dragged through the streets of Mogidishu. These images created a clamor from the American public, and soon Congress, for the United States to leave Somalia since there was no strategic necessity to be there. The withdrawal of U.S. troops took place soon thereafter [3]. This was a foreign policy failure for the United States as it sent the message that if someone like Aidid can easily evict the U.S. military then anyone can. This was an instance when United States Foreign Policy was directly affected by the exploitation of downed American servicemen.

The loss of sensitive information also applies to the equipment that soldiers carry on their missions. Technological advances have lead to many innovations to help modern military forces better attain their objectives. Many of these innovations can be carried with soldiers into battle. While they help soldiers to complete their missions better with less risk, many contain sensitive information that will be harmful if captured by the enemy. The technology associated with much of this equipment is classified as well. Allowing a newly developed system to be captured helps the enemy to obtain new capabilities. Nations spend vast resources to gain a technological lead on the battlefield. Captured assets let the enemy catch up quickly.

The loss of equipment also reduces the capability of the force in theatre, as replacements may not be readily available. Recovery of assets allows these forces to continue performing their missions as originally planned. The financial loss associated with un-recovered assets can be a factor, as technological advances require extensive funding. Recovery of expensive assets allows strained resources to be used for other activities.

Combat Search and Rescue Requirements

Establishing and maintaining CSAR capability requires substantial top-level support and funding. It must become an integral part of the defense infrastructure. Though evidence suggests that political and military leaders are now committed to maintaining an effective CSAR capability, recent times have seen CSAR assets to be among the first to arrive in new theatres of operation, this has not always been the case. During times of war, the need is recognized and CSAR forces are built up through a considerable effort. When hostilities cease, this element of the military is among the first to be cut back. Little attention is paid to CSAR until the next time hostilities breakout and it is evident how much this capability has deteriorated, at which point the rebuilding effort begins again. However, this leaves a big hole in our military capability during the early part of the conflict. Maintaining a proficient CSAR force through peacetime ensures that this capability will be ready when needed.

Effective CSAR capability has many, complex components. CSAR forces are more than merely air ambulances or medical evacuations. They are combatants, capable of fighting and operating without the special protection of the laws of war. These forces are heavily armed and are required to take offensive as well as defensive actions. To make sure they are ready when needed requires dedicated, specialized personnel and equipment. Though all branches of the military have this capability to some extent, the United States Department of Defense has designated the U.S. Air Force as the lead service for Combat Search and Rescue [4]. Thus, this paper will focus on the actions of the U.S. Air Force to improve this capability.

The first requirement for maintaining a proficient capability is to dedicate the proper personnel and assets to a force whose primary task is CSAR. In the past, CSAR has been assigned as a secondary task to other units. The Special Operations Forces have been the prime candidates called on to accept this responsibility during peacetime. While the unique make up of the Special Operations Forces give them the capability to perform this task, when hostilities break out they focus on their primary mission. CSAR operations are then either given to unprepared units or they take Special Operations assets away from their primary missions. The U.S. Air Force, recognizing this need, has created a permanent CSAR force under the guidance of the Air Combat Command.

A primary requirement for CSAR operations is the ability to get to downed personnel, in any environment, as quickly as possible. This means that these forces must be able to travel potentially long distances, at all times of the day or night, in any weather conditions. They also must be able to reach remote and rugged regions of the world. A further variable is the fact that the enemy will try to stop any rescue attempt, hence, the combat portion of the operation. To satisfy this requirement the U.S. Air Force uses two operational aircraft, the HC-130N/P Combat Shadow and HH-60G Pave Hawk helicopter.

The Pave Hawk is the primary and preferred recovery vehicle as it can fly low level, day or night, in marginal weather while accessing remote areas and regions. It is specially enhanced version of the H-60 helicopter. The unique capabilities of the Pave Hawk helicopter will be expanded in a later chapter, as it is the focus of this paper.

The HC-130N/P Combat Shadow is a specially equipped fixed-wing tanker. It can refuel the Pave hawk helicopter in flight, providing the CSAR team a longer range of operations. At times, this refueling may take place in contested air space. The HC-130N/P can also air drop supplies and rescue personnel to isolated forces. This aircraft has expanded communications systems as well as increased defensive systems. The ability to communicate with the accompanying Pave Hawk helicopter while in enemy territory cannot be overestimated. The HC-130N/P monitors the situation and provides the rescue team information needed to ensure the highest possibility of survival. The two aircraft must be able to function in tandem to eliminate as many risks as possible. The technology that makes this possible will be dealt with later in this paper.

Though the personnel assigned to these units are a critical aspect of CSAR capability, this paper will only briefly examine their role. Though each member of a rescue team has a different specialty, they must all work together as a cohesive unit to be successful. This means they must co-exist and train together as a unit and not just come together when the need arises.

There are several types of personnel that make up a CSAR crew. Obviously pilots are a key requirement. However, these need to be some of the best pilots in the Air Force, as they need to fly accurately in dangerous conditions, often under fire. Many rescue scenarios tax pilot expertise to the maximum. Flight engineers perform such functions as manning side window guns and otherwise assisting the pilots. They also man the hoist when personnel need to be recovered from a place where the helicopter cannot land and must hover above the rescue site. To handle the rescue portion of the mission are specially trained soldiers called Individual Para-rescue Specialists, often called PJs.

The PJs are the vital link between the recovery aircraft and the downed personnel. Besides performing any medical care necessary at the recovery site, they also provide security for the rescue area. If necessary, PJs are also specially trained in Survival, Evasion, Resistance and Escape (SERE) techniques [5]. Since these are considered combat missions, they are prepared to fight if needed to complete their mission. PJs are dropped onto the downed site even if the rescue aircraft cannot land. In these cases, the PJs must lead the recovery team, with recovered personnel, to a site more suitable for aircraft landing. This scenario is often accompanied within hostile territory with downed personnel who may be seriously wounded.

As mentioned earlier, these personnel must be specially trained in their areas of expertise within the context of CSAR missions. They must train often and together so that all personnel are familiar with all aspects of the mission. The teams sent on CSAR missions should be kept together in the same unit so that they will be ready on short notice to help their fellow service men and women. The rate of survival for the crew of a downed aircraft decreases with time. Having the teams already in cohesive units with some teams actively ready at all times is vital to mission success.

Role of the Pave Hawk Helicopter in Combat Search and Rescue

This section will focus on current Combat Search and Rescue procedures and how the Pave Hawk helicopter is utilized during CSAR operations.

The first step toward completing a CSAR mission is for the rescue team to be notified that one or more people are isolated in a dangerous situation. Downed personnel may establish radio contact to relay their problem or another aircraft or military unit may relay this information. Radio contact in these situations should be brief to avoid enemy detection and location of downed personnel. While radio contact helps friendly forces identify and locate downed personnel, it also gives the enemy the same information.

Once notified, the Pave Hawk crews should be ready to respond as quickly as possible. As mentioned earlier, CSAR is a very time-sensitive operation. Statistics show that the first Five hours are critical for recovering downed personnel. At five hours the rate of survival is 20% and decreases rapidly after that [5]. The speed with which the team reaches the rescue site is the most critical factor in CSAR operations. Rescue teams should be optimally positioned in theatre to reach all areas of military operations in the minimum amount of time. Rescue crews should be ready at all times to quickly respond to a call for help.

While the Pave Hawk aircrews prepare to liftoff, the rescue situation is assessed to determine what risks and threats will be encountered on the mission. A thorough understanding of the situation is vital to making a decision on the feasibility of the mission and the best method to accomplish the mission. Information such as weather, terrain and enemy threats should be gathered. There are generally two types of threat information: areas identified where the enemy can detect rescue crews and areas where enemy weapons can destroy rescue crews. Threats are avoided if possible. If the downed personnel are in a high threat are, which is often the case, then steps can be taken to minimize the risks. This can include waiting until night, if practical, or creating diversions in other areas. Locations of enemy radars and weapon systems can change rapidly and new ones can appear. Therefore, current intelligence reports are critical to identifying enemy threats and preparing for them.

Once the risks are identified, steps can be taken to minimize the risks and increase the chances of mission success and survivability. The gathering of pertinent data and consolidating it into a manageable entity from which decisions can be made is key to effectively planning CSAR missions. The automation of this process is necessary to making planning decisions correctly and quickly

Operations in increased threat environments require significant planning to ensure mission success. To reach downed personnel within the stated goal of five hours means a whole lot of things must happen in a short amount of time. Merely notifying the rescue forces, getting them in the air and to the downed site can consume a large portion of the five hours. Preparing the mission so that a rescue crew is not flying a helicopter blindly into enemy territory requires a lot of consideration. It is in this area of mission planning that many advances have been developed to ensure that the aircrews can respond quickly to an emergency situation with the best chance of success and survivability. These mission advances are the subject of this paper and will be dealt with more fully later in this paper. The important point here is that improvements in both the speed and quality of mission planning are essential for successfully recovering downed personnel.

Once the mission is planned the Pave Hawk rescue team executes the mission. The search is the first phase of the operation. Many new innovations have removed the guesswork involved with locating downed personnel. The navigation systems aboard the Pave Hawk and other recovery aircraft allow recovery teams to proceed to the precise location, removing the dangerous practice of performing search patterns. Enhancements in satellite communication technology allow rescue crews to receive changes to the mission plan without compromising their position and mission through radio communications. New advances also allow these crews to receive current updates to that all important threat data.

The identification of downed personnel must be authenticated before the Pave Hawk is sent into a hostile environment. Enemy forces may be using downed personnel and equipment to lure more forces into a trap. All military personnel have personal information on file, which can be used for identification purposes, and have been trained on authentication procedures. This personal information is extremely sensitive and must be guarded.

Downed personnel, found and identified, may not be immediately accessible but they may need immediate help. In this case, the rescue team can drop equipment and PJs to support the downed personnel until the rescue aircraft can land safely. As mentioned before, these PJs are combat troops that can take the offensive if necessary. They help downed personnel to resist or evade enemy troops and to remove them to a safer recovery location as well as provide medical attention to injured personnel.

The return from a rescue mission is often the most dangerous part of the operation. The navigation system of the Pave Hawk allows the rescue crew to sneak into enemy territory by flying low and avoiding threat areas. The element of surprise also aids the rescue crew while first entering enemy territory. However, by the time downed personnel are recovered, the enemy is often aware of the mission and is actively seeking out the Pave Hawk in order to shoot it down. The rescue of Air Force Captain Scott O'Grady, while not performed by a Pave Hawk, is still a good illustration of this principle. Captain O'Grady was shot down over Bosnia in 1995, deep behind enemy lines. After six days of evading the enemy he was located and recovered. The recovery aircraft encountered no resistance on the journey to the recovery site. However, the return trip was entirely different The enemy, alerted to the mission, was waiting and greeted the rescue aircraft with machine gun fire and Surface to Air Missiles (SAMs).

Pave Hawk Advances

The U.S. Air Force is taking full advantage of new technologies and processes to improve its CSAR capabilities. The main focus of these improvements has been in reducing the time required to locate and recover downed personnel. The 422nd Test and Evaluation Squadron (TES) at Nellis Air Force Base has spearheaded the move to increase the CSAR capability of the Pave Hawk. The HH-60G Pave Hawk is being equipped with new systems that indeed take the rescue crews to a precise spot in a short amount of time. The improvement of time-sensitive-targeting processes has significantly improved recovery times and survivor rates. During a recent Joint Expeditionary Forces Experiment (JEFX), the Pave Hawk demonstrated dramatic, measurable improvement in its CSAR capability. The standard 5-hour rescue mission was reduced to 1.8 hours. This reduction in response time increases survivability from 20% to 60% [6].

The use of satellite technology for both navigation and communications systems has significantly improved the capability of the Pave Hawk helicopter. The Pave Hawk combines survival radios with data links and satellite communications to take the guesswork out of the search phase of rescue missions. The search is more electronic in nature with GPS technology providing the rescue crews with the precise location of the downed personnel, even if they are required to move from the original site.

Communicating with downed personnel is currently accomplished via the Hook-112B Survival Radio System. This is a handheld system contains a voice radio and a beacon signal to communicate with rescue crews. An imbedded GPS receiver allows downed personnel to gain accurate coordinates for their position and then relays that information to the Pave Hawk crews. However, this system requires line of sight for the radio that may limit the range of communication. Plus, there is the added problem of radio signals being intercepted by the enemy. The Hook-112B uses encrypted messaging but the radio signals alert the enemy to activity in the region and are traceable if used too much.

One new innovation that will vastly improve this situation is the development of the Combat Survivor Evader Locater (CSEL) system. CSEL will provide reliable 24-hour two-way near real-time secure messaging and communications. All military personnel will be equipped with a hand-held CSEL user segment that can relay vital information such as position and a situational analysis via satellite communications. Mission data and passwords can also be communicated. A Global Positioning System (GPS) receiver provides precise position location and the satellite communications are encrypted so that communications can be neither understood nor tracked. While this is not a specific item for the Pave Hawk, CSEL interfaces with other Pave Hawk systems to vastly increase CSAR capability [7].

Once the coordinates for the rescue site are determined, the Pave Hawk uses one of the most advanced navigation systems in the world to fly to that precise position. As mentioned previously, CSAR is a time sensitive and dangerous operation. Rescue crews cannot afford to waste time searching a general area for downed personnel. They need to get there, recover the personnel and get out as quickly as possible. The Enhanced Navigation System (ENS) of the Pave Hawk uses a Kalman Filter to combine several navigation systems into one integrated and accurate navigation solution. The GPS, Inertial Navigation System and Doppler Navigation System are the primary inputs used by the Kalman filter. This filter is a complex mathematical model that assesses the current accuracy of each system and then uses that information to derive the most accurate navigation solution possible. The Pave Hawk ENS has been fined tuned to the point where there is virtually no visible searching needed at the rescue site.

Pave Hawk crews have begun using tablet like portable laptop computer, called an Electronic Link Mission Overlay (ELMO), which places the survivor's GPS location and the helicopter's location on maps and photos. It also displays threat intelligence so that the pilots can see the obstacles between them and the downed personnel. A new system that is currently employed on just a few Pave Hawk helicopters is called Have CSAR. This system provides position data and threat information to be viewed on multifunction displays in the cockpit.

Threat intelligence is received via the Multi-mission Advanced Tactical Terminal (MATT). The MATT is a satellite communication enhancement that has been a particularly valuable addition to Combat Search and Rescue teams. It is a UHF receiver that can be used at a fixed site for mission planning purposes or onboard an aircraft. It provides threat data to rescue crews without compromising the mission.

The use of data links to share information among all parties in a rescue operation, including the downed personnel, is a new innovational which will vastly improve situational awareness. The new Situational Awareness Data Links (SADL) system uses Link-16 data links to accomplish this goal. These systems will allow all members of a rescue operation to be aware of positions of other friendly forces as well as the position of the downed personnel. This system will work in conjunction with a yet to be developed Global Personnel Recovery System (GPRS). GPRS is a GPS system that will decrease the time it takes to receive distress alerts from downed personnel along with their position [8]. These improvements significantly improve command and control as leaders on the ground can monitor rescue operations without breaking radio silence.

The greatest risk for a rescue team is at the site of recovery. More helicopters have been lost during this phase of the mission than in any other. In the past, the Pave Hawk was lightly armed for defensive purposes and relied on combat escorts to protect it on the way to a rescue site. However, these escorts often could not support the rescue crews at the recovery site, the most crucial area. Pave Hawk recovery teams are now being transformed into heavier combat units that can provide offensive power if necessary.

One new innovation, which will improve survivability at the recovery site, is a Self-Protection System (SPS). This system can automatically detect air-to-air and surface-to-air missiles that have been fired at the aircraft. Currently, the aircrews must be on the look out for incoming missiles and dispense the proper countermeasures manually. This system uses plume signatures to detect the type of missile and the correct countermeasures to be taken. The new SPS system can dispense four types of flares as well as chaff cartridges [6].

Another enhancement that improves survivability at the recovery site is the addition of a .50-caliber machine gun that can be fired by the gunner or through the pilot's controls. The ammunition supply for this gun is mounted outside the Pave Hawk cabin. This allows more room for personnel and equipment. Forward firing missiles and other weapon systems are being considered for addition to the Pave Hawk to increase its combat and defensive capabilities.

Mission Planning Advances

Many increases in the Pave Hawk's CSAR capability have been made through advances in the mission planning phase of the rescue operation. As mentioned previously, personnel recovery operations require extensive mission planning. This planning must happen quickly if the Pave Hawk crews are to make it to the rescue site within the stated five-hour goal. The development of a single, automated system for collecting and presenting situational data and other information pertinent to planning a rescue mission was the first step toward improving the response times of CSAR forces.

The Air Force Mission Planning Support System (AFMSS) was developed for just this purpose. Used for both fixed and rotary wing aircraft, AFMSS combines situational intelligence with aircraft capability to determine the best plan for recovering downed personnel. This information can be used to evaluate the feasibility of the rescue operation and then to develop the optimal flight plan for reaching downed personnel.

AFMSS is a software intensive system that interfaces with many of the technologically advanced systems previously mentioned, especially in the areas of communication and intelligence. It is composed of two parts: the Mission Planning System (MPS), a core software program common to all aircraft, plus a unique Aircraft/Weapons/Electronics (AWE) software module for each aircraft.

The AFMSS MPS had the capability to interface with software based Theatre Battle Management systems. This gives leaders greater command and control as decisions can be uniformly and consistently relayed to all military units involved in a given operation. AFMSS MPS could also import current intelligence, weather and other pertinent data to ensure that every aspect of flight planning was performed with accurate information. This data is combined with digitized map terrain and imagery data to give the mission planner the most complete situational picture possible.

Once planned, the mission data could be downed loaded to a data transfer device, the Smith Industries 32K Data Transfer Module (DTM) was used. This DTM could then be taken to the helicopter and the mission data could be uploaded to the mission database of the Pave Hawk navigation system. The flight plan, threat areas and other mission information was automatically entered where previously the Flight Engineer had to manually input this information through the Control Display Unit (CDU), a very cumbersome and time consuming procedure.

The MPS was originally developed on a Unix based platform that was comprised of both a ground system and a portable system. It used an open architecture, which allowed future hardware and software enhancements to be easily implemented. The use of Commercial-Off-The-Shelf (COTS) equipment was a feature new to the Department of Defense at the time. The military has historically used parts that were customized for a unique need.

The use of COTS equipment is beneficial in several ways. First of all, COTS products are considerably cheaper than customized products. COTS development costs are spread throughout the industry. To have a product custom built means that the Department of Defense must bear the full brunt of development costs. It also allows the military to stay in sync with industry, thereby taking advantage of product enhancements without redesigning the system. Recruiting of technical personnel is enhanced, as the skills needed for military applications are the same as those for private industry.

The MPS ground system was built upon the Sun Microsystems Sparcstation 10 and Sparcstation 20 and uses X Window and Motif graphical interfaces. The MPS ground system comes in six separate containers and was intended for use at the aircraft's main operation base. The Portable Mission Planning System (PMPS) was a smaller, more portable version of the MPS ground system and was intended for use in the field [9].

However, MPS experienced some reliability problems and did not always effectively generate a flight plan in the time needed. MPS evolved through several iterations and improved considerably. The users, however, preferred the smaller PMPS and also preferred a system that would run on a standard, Windows based PC. This requirement plus other enhancements requested led to the development of the Portable Flight Planning System (PFPS).

PFPS uses the Windows operating system and the Windows graphical user interface, which allows it to operate on inexpensive, commercially available PCs, both desktops and laptops. To further simplify the product, the Data Transfer System was changed to use a standard 3.5-inch diskette instead of the customized data cartridge. This reduces the need for an extra data transfer receptacle to be connected to the mission planning PC and the need for a supply of relatively expensive Data Transfer Modules. Once the flight is planned, all data are saved to a common 3.5-inch diskette that is then taken to the aircraft and downloaded directly into the navigation system. All hardware requirements are now pared down to a single commercial PC that can be purchased from numerous sources.

PFPS in conjunction with the Pave Hawk AWE comprise the mission planning system for the Pave Hawk. While the core system has evolved from the original MPS to PFPS, the AWE has followed its own improvement path. It also is Windows based and written in the industry standard Visual C++ programming language. Many other enhancements have been made to it as well. The Pave Hawk AWE takes several separate products and integrates them together to form a comprehensive mission plan.

When developing a plan, the AWE bases its route planning on the flying capabilities of the Pave Hawk. A flight Performance Module (FPM) provides detailed and accurate information on the flying characteristics of the Pave Hawk, giving the mission planner the limits of what can be done on a particular mission.

The AWE also provides the mission planner with the latest weather and threat information. Updated digital maps, with accurate terrain data, are also a necessity. One of the biggest dangers to the Pave Hawk is the increased risk of an in flight accident. To avoid detection, The Pave Hawk flies as low to the ground as possible. Knowing the terrain is vital as well as having updated information on vertical obstruction data that exists along the flight plan. Vertical obstruction data take into account man made structures that can change rapidly or appear overnight. This includes things such as power lines, water towers and other things that a low flying helicopter could hit. The proliferation of new mobile telephone towers around the world means that vertical obstruction data must be updated constantly.

As mentioned earlier, the use of satellite communications and data links have significantly enhanced the flow and timeliness of information.

Innovations such as CSEL, MATT and other communications systems have driven changes to the AWE. Newer innovations such as GPRS and SADL will also drive changes to the AWE as well as other enhancements to help the mission planner develop a better plan quicker. The Software Engineering Division at Robins AFB works with the Pave Hawk System Program Office and the users to identify and implement improvements to mission planning software.

A new mission planning system is currently being developed to replace AFMSS. The Joint Mission Planning System (JMPS) will be a common mission planning system for all United States military branches. JMPS capability will primarily be based on the best features of the mission planning systems of the various branches of the military. Though some improvements to the product will be incorporated, the immediate benefit is one system common to all services. This allows better command and control of military operations, especially those planned at a high level, so that all participants in a mission are receiving the same information and the same plan.

The Pave Hawk unique AWE will be replaced in this new system by a similar Unique Programmable Component (UPC). Again the AWE and the UPC will perform the same function with the UPC becoming the Department of Defense standard.

Summary

All levels of the government and military finally accept the tactical and strategic importance of Combat Search and Rescue. The dedication of certain troops to improving and maintaining CSAR capability is probably the biggest advance in this are of the military. Integrating these troops into the total theatre force makes them part of the combat force and not just an ancillary appendage to be called upon in an emergency.

The Air Force is still the primary agency for providing CSAR capabilities and the HH-60G Pave Hawk helicopter is the prime aircraft for recovering downed personnel. Because of this, the Air Force has put considerable effort into ensuring that it can perform this task with the best chance for success.

Many technical innovations have improved the availability and sharing of vital information. These innovations have been implemented on the Pave Hawk and new innovations will be added as they become feasible. The mission planning software serves as the focal point for the automatic receiving of important mission data and making it available to the mission planner in a usable format. Collecting and sorting out this information in order to make a good command decision has been reduced from 4 hours to about 30 minutes. This is a critical factor in reducing the time it takes a rescue crew to reach downed personnel.

Further enhancements to the processes, the Pave Hawk Helicopter and the mission planning system will continue to improve the United States CSAR capability.

Bibliography

[1] Handy, General John, from an address to the *DoD Personnel Recovery Conference,* 23 January 2001

[2] Blumentritt, Major John, "*Playing Defense and offense: Employing Rescue Resources as Offensive Weapons,"* Air War College, Maxwell AFB, AL, May 1999, pp. 1-16

[3] Slogan, Patrick J., "Series: Mission to Somalia", Newsday, December 5, 1993

[4] Pike, John, "Combat Search and Rescue (CSAR)", Federation of American Scientists, March 28, 1999

[5] HQ AFDC/DR (Lt Col Richard W. Feeser), "*Combat Search and Rescue Air Force Doctrine Document 2-1.6"*, 30 September 1998, pp.12-22

[6] Scott, William B., "*Combat Search and Rescue: Model for Transformation",* 11 March 2002 edition of *Aviation Week and Space Technology*

[7] *CSEL* Public Affairs*, "Military Search-and-Rescue Improved with addition of CSEL",* 13 February 2002

[8] *Steward, LCDR Paul, "Global Personnel Recovery System: Public Overview",* 23 January 2001

[9] Slabodkin, Gregory, "Air Force uses Network System for Flight Operations", Government Computer News, August 13, 1998