FLIGHT SAFETY FOUNDATION
HELICOPTER SAFETY
Vol. 15 No. 4 *For Everyone Concerned with the Safety of Flight* July/August 1989

# Helicopter Crew Work Loads Studied by Video/Computer Research

***A new approach to time and motion studies reveals significant information about the interaction of vehicles and flight personnel.***

*by*

*Charles Spence*

During certain flight conditions, some military helicopter crews perform a task on an average of every 2.5 seconds. With many tasks requiring up to 10 seconds to complete, the work load demands that crew members execute two or more activities simultaneously.

Data such as this provide a framework on which engineers, designers, instructors and others concerned with productivity and safety can build.

Knowing the frequency of tasks, the time required to do them, whether they are regularly done alone or with other crew members, whether initiated by the crew or compelled by an outside force, all can help in deciding placement of instruments and controls and assigning duties for better efficiency and safety.

If this sounds like human factors research, it is. However, this has a new approach.

A small business in Potomac, Md., U.S., near Washington, D.C., combines television cameras with computer technology to evaluate the interaction between humans, the system and the machine.

Through this process, the staff of Paradigm, Inc. developed the 2.5 second average for four crew members of a particular U.S. Navy helicopter. The company conducted this most recent study at the Patuxent River Naval Air station. It delivered the report to the Navy in late May. Full details have yet to be released.

Although the company has been in the "people problems" business since 1976, it was not until four years ago that the firm explored the application of video/audio analysis to the assessment of a work load.

Paradigm President Margaret T. Shaffer got a subcontract from the Federal Systems Division of IBM Corporation. It involved the LHX/ARTI—Light Helicopter Experimental/Advanced Rotorcraft Technology Integration.

## Single Pilot Capabilities Studied

An important question demanded an answer. Instead of two persons aboard, a pilot and an observer, could one crew member fly the aircraft and operate all the installed systems?

Time and motion studies had long been done by personal observation, with a clipboard and stop watch. Such techniques, however, suffer several drawbacks when applied to a complex behavior or multi-person involvement such as helicopter crew members find in combat conditions or complex commercial operations.

Putting a time and motion observer into the vehicle is impractical. Simulation removes stress and places the subjects in an artificial environment. Also, evaluation is subject to the observer's ability or inability to be aware of and record a multitude of actions simultaneously.

Paradigm solved these problems by video taping crews under actual flight conditions. The first covered exercises in OH-58D helicopters flown at Ft. Hunter-Liggett, Calif. Going frame by frame on the video image, researchers transferred data from several sources, such as actions by different crew members, radio communications, chart reading, terrain search or instrument reading to a computerized single transcript. From this, researchers could analyze all information together.

Using this method of time and motion study, any measure of performance visible or audible on the tape can be tied to a particular time hack and studied.

The initial study for the LHX identified certain categories of functions that must be automated to reduce the work load before a single pilot could safely and effectively conduct missions now requiring two crew members.

## Civilian Applications of the Studies

While work thus far has centered on military helicopter operations, data gathered can influence civilian vehicles and systems as engineers apply lessons gleaned from military studies. Similarly, special studies adapted to civilian operations can provide detailed data to help improve efficiency and avoid design-induced accidents.

After proving the approach for the LHX project, the company conducted a second helicopter study for the Canadian Department of Defence. This work was a subcontract from Canadian Marconi Company.

Canadian forces are moving to replace CH-136 (Kiowa) light observation helicopters with a more complex aircraft. The CH-136 is a militarized version of the Bell 206, JetRanger. Little distinguishes the military craft from the civilian version. Its replacement almost certainly will have more sophisticated navigation systems, complex sensors and target acquisition systems.

These will introduce new tasks for the crew. How best to integrate these tasks into the fixed requirements of aircraft control, communications, navigation and other mission actions poses unique challenges.

Before deciding the final configuration of the new aircraft, its systems placements and division of crew duties, planners needed a baseline of existing work loads. By close study of the CH-136 and its crew in actual flight conditions, a more efficient and safer replacement will be produced.

As Shaffer explains, “If a pilot refers to a particular instrument infrequently it may be placed in a less accessible position than one requiring attention more often.” As another example, she points to tasks which may be done often while the crew member also must tend to other duties. These may require more automation, different placement or shifted assignment responsibilities.

The project does not attempt to make specific recommendations. Its role is to provide complete data of task frequency and duration on which others may draw for decision making.

Gathering these data is through what Paradigm calls Empirically Validated Task Analysis (EVTA). The essential features of the EVTA process are the use of audio/video equipment and a computer software package. The video gathers permanent records of operator activities in operational environments. By putting data from these into the computer, the software creates an empirical record — one capable of proof by observation.

To secure taped records, a miniature video camera with an auto-iris lens was mounted behind and between the crew seats. At about shoulder height, the camera covered a field of view including the instrument panel, center console, chin windows and the lower portion of the forward windscreen.

This position also provided recordings of hand movements by each crew member. Through the forward screen, the camera caught enough of the terrain to reveal the flight mode, showing low level, contour or nap-of-the-earth status.

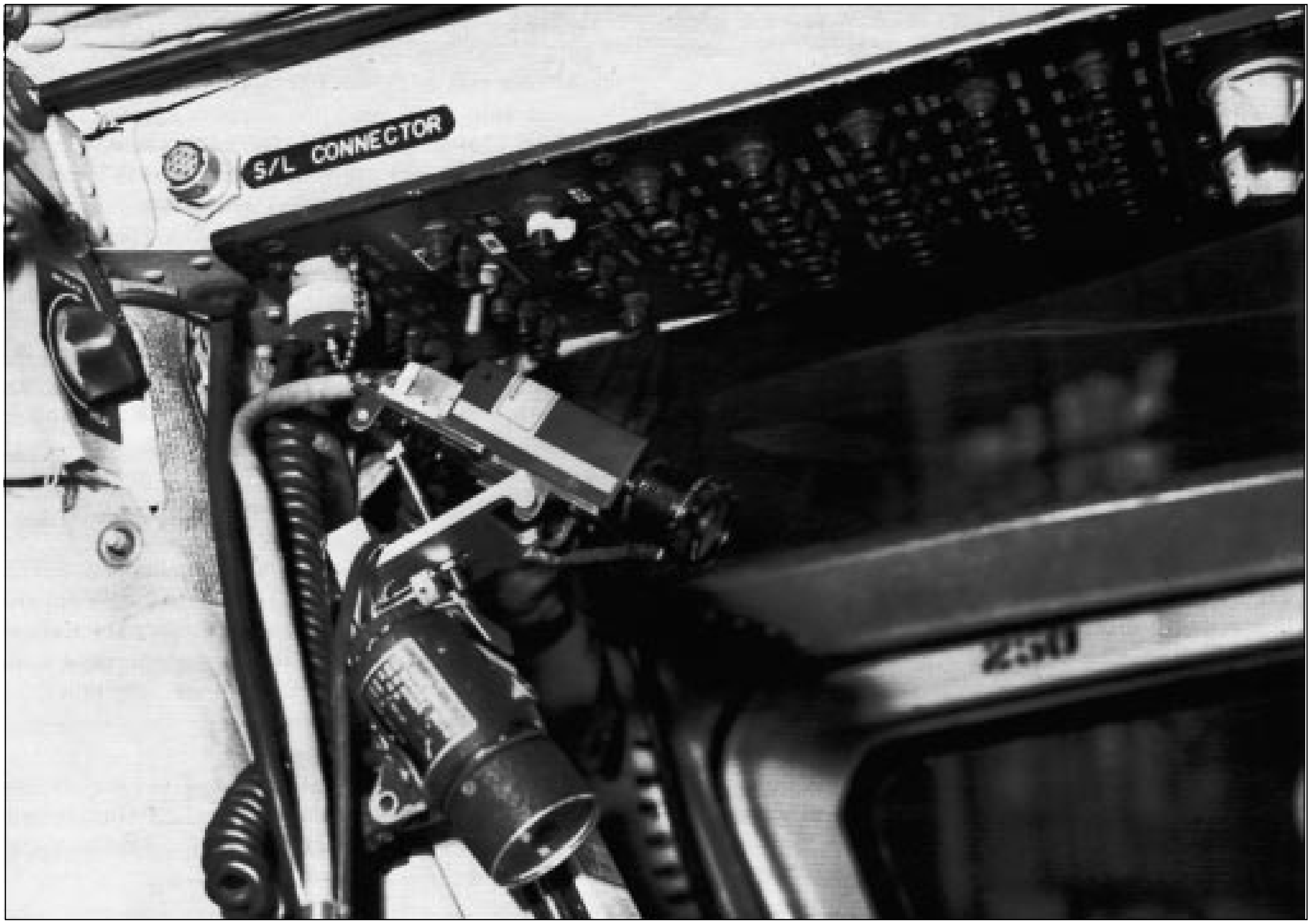
Placing the camera behind the crew provided the most visibility of significant elements for the study and also kept the crew members in almost silhouette, helping to maintain anonymity. One source of information missed by this method, however, is head and eye movement.

Obviously, neither method of evaluation records thought processes. Problem solving, decision making, calculations and other cognitive actions add to the multiple action demands on crew members.

Inserting a time code generator in the camera recorded time information on the tapes. Installing the camera in the aircraft can take as little as 20 minutes. Audio recorded all communications; incoming, outgoing and internal.

## Operational Missions Add Realism

Different crews first conducted eight flights for the video records. These simulated actual operation missions. To gain realism and record as closely as possible to actual mission conditions, the flights followed a scenario. The helicopters provided support for a motorized reconnaissance unit. They also included aerial reconnaissance, forward air control of fighters and aerial observation in




*To record crew tasks, a miniature tv camera was mounted at the base of the overhead panel at the rear of the cockpit, where it could "look" over the pilots' shoulders while they performed flying tasks.*

support of live-firing artillery.

A second series of tapes recorded flight actions during exercises in Canada and the Federal Republic of Germany.

## Selecting Tapes for Further Analysis

From these total recordings, covering 12 hours of flight, Shaffer and her team of experts selected six for evaluation and data transfer.

A first step identified each observable action or communication and assigned each to a specific category and recorded the start and stop times.

Researchers may enter data in any order. This permits several analysts to divide the work and then recombine it in a time sequential format. For example, one analyst can make communication entries, another records multifunctional display information, while a third records other activities. The software program then sorts the records by start-time to produce a time-based transcript. A search capability allows the researcher to find a record that begins at a particular time.

Once in the computer, this information forms the basic data source. A print-out shows what tasks or communications are made by which crew member at precisely what point in a flight and what other actions or communications may be occurring at the same time. It also reveals the frequency of occurrence and percentage of mission time given to each task.

By selecting tape recordings from Canada and from Germany the study clearly showed the differences in work load and time spent on tasks when flying over unfamiliar terrain as opposed to home territory. In an unfamiliar environment, the task load in transit increased to 1.5 times that for operation over familiar routes. Transit time covered portions of the flight from base to the mission area, between missions and to a forward area refueling point.

In the unfamiliar environment, navigation and communications related to navigation required 85 percent of the task load. This compares with only 24 percent when flying over familiar areas.

Reaching the forward edge of the exercise battle area, boosted the task load to twice that of transit flight over familiar terrain.

The task analysis team recorded more than 60,000 data points for the two crew members aboard the CH-136. These revealed 219 task categories. On 399 times during the 12 recorded hours, the observer engaged in multiple concurrent tasks.

Identifying tasks in this manner significantly helps select those subsystems which can benefit most from engineering or design changes.

Communicating these needs to engineers in the past has been difficult because of the absence of hard data. Much of the previous information has been subjective, not readily accepted by most engineers.

By contrast, the EVTA process provides not only a computer-generated data base but this can be supported by snips of the actual video/audio tape from which the information was taken. This provides to the engineer not only the computer-generated data but visual back up of the performance of the task itself.

## Improving the Sessions

The first EVTA project seems primitive compared with advances made by Paradigm. The study recently completed for the U.S. Navy, for instance, used multiplex video systems. Four cameras were placed in the helicopter. These covered each of the four crew members. Taped records were then presented on four monitors simultaneously for analysis by the EVTA process.

The tedious task of manually recording each task and its start and stop time made the process extremely labor intensive. This stage of work has been advanced, also. Start and stop times are read directly from the video cassette recorder. One channel of the tape records the time. This feeds directly to a synchronized time generator which permits the capability for data entry with a single key stroke.

As a result, reports are produced more quickly and the hours of labor, and consequently the expenses, are reduced. The company's staff includes professional pilots. Also, when necessary, subject experts from the agency or company for whom the research is being done are utilized to help assess the tasks accurately.

This "real world" information about helicopter operations, although derived thus far from military experience, nevertheless confirms several beliefs for civilian flying. Most obvious is proof that flying into unfamiliar areas requires considerably more crew attention than does flight in known territories.

This information alone, Shaffer says, gives the civilian pilot supportive data to install navigation aids, refrain from idle chatter with passengers and keep communication and flight skills sharp.

Further information leading to better design for safety and distribution of task responsibilities are possible "anywhere we can install a tiny video camera," says Shaffer.

Don't be surprised if someday, somewhere, somebody says "Smile, you're on a research camera!" ♦



**HELICOPTER SAFETY**

**Copyright © 1989 FLIGHT SAFETY FOUNDATION, INC. ISSN 0898-8145**