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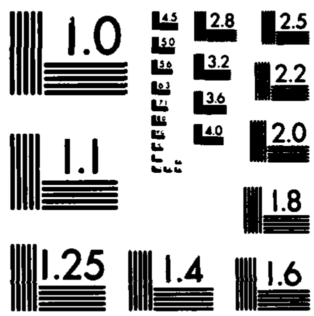
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by

Richard Diamond

December 1982

Thesis Advisor: J.W. Creighton

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The techniques of simple linear regression and nonparametric statistics indicated that the greater the experience level the better performance level achieved. The analysis of crews determined that less experienced crews

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Pilot Selection Criteria for the AH-64 Helicopter

by

Richard Diamond
Major, United States Army
B.S., University of Albuquerque, 1975

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December 1982

Author: Richard Diamond

Approved by: John W. Creighton
Thesis Advisor

James F. Henn
Co-Advisor

Chairman, Department of Administrative Sciences

W. M. Woods
Dean of Information and Policy Sciences

ABSTRACT

This thesis uses statistical analysis methods and subjective decisions to determine the parameters necessary to establish crew selection criteria for the AH-64 attack helicopter. The purpose of establishing these parameters is to aid the Army in establishing pilot selection criteria for the AH-64.

The techniques of simple linear regression and nonparametric statistics indicated that the greater the experience level the better performance level achieved. The analysis of crews determined that less experienced crews performed proportionately as well as the more experienced crews. Curiously, the amount of experience of the pilot is not a determining factor, whereas the copilot gunners experience is directly related to how well the crew performed. Crew selection for the AH-64 helicopter should be made from the existing AH-1 series community of aviators with the more experienced aviators performing duties as copilot gunner.

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I. INTRODUCTION

The Army conducts operational tests on equipment to determine the feasibility of a new system. Feasibility is determined during the Demonstration and Validation of alternatives phase of a systems development. OT's are conducted to test the operational suitability, military utility, and operational effectiveness of the system. OT I tests are to determine potential operational suitability and effectiveness and OT II tests demonstrate operational suitability, military utility, and operational effectiveness leading to the production decision.

To adequately test the new system in an operational environment a tactical unit is tasked to put the new system through a rigorous tactically oriented test. This method enables the Army to evaluate the tactical employment feasibility and whether an active duty unit can operate, maintain, and employ the new system in a tactical environment.

The unit chosen to participate in the operational test is supposed to be a typical Army unit. The range of experience and expertise should mirror the current level of training in the Army. In this way, if the new system is purchased and deployed, no special criteria will have to be established to field the new system.

The Advanced Attack Helicopter Test (AAH) design was in accordance with the above doctrine. D Company, 7th Combat Aviation Battalion was the tactical unit chosen to participate in the test. The unit was required to fly and maintain the AH-64 for a period of 90 days in a tactical environment. Fort Hunter-Liggett was selected as the test site; it is situated in the mountainous coastal region of middle California and offers a myriad of terrain which closely approximates Western Europe. D Company conducted all operations in a field environment under the control of its chain of command. Test requirements were passed through the chain of command to add realism to the scenario and to maintain tactical integrity of the unit. This was the environment in which the AAH test was conducted.

A. PURPOSE

This thesis measures subjective versus objective decisions involved in the pilot selection for the AH-64 operational test. It is intended to provide a method of selection of pilots for the AH-64 using other than statistical inference as a measure of experience.

Experience is measured in many different ways; maturity, common sense, adaptability, and expertise. It is essential that all these elements be weighed so the selection process provides the most qualified individuals. The initial selection process for the Advance Attack

Helicopter Test was in accordance with the operational test plan and current Army regulations. The selection, however, was overturned by TRADOC and the Program Manager. These agencies wanted a minimum flight hour requirement placed on those pilots selected to fly the AH-64. The participating unit did not have sufficient pilots to cover the flight hour requirement; thus, pilots from outside the unit had to be brought in to supplement the unit. The pilots chosen were supposed to mirror the experience level of Army aviators; however, the hourly requirement restriction put the AH-64 pilots in an arena by themselves. These pilots far exceeded the experience of the normal Army aviators, and in fact, were more closely associated with the more experienced instructor pilot population. The difference between the AH-64 population and the normal population will be measured to show that flight hours are not the only means of measuring an individual's quality and performance level; rather, a subjective measure of his ability to adapt to a new environment is equally important.

II. PILOT SELECTION PROCESS FOR THE AAH TEST

Pilot selection for the Advanced Attack Helicopter Test began in August 1980. D Company was chosen as the operational unit to conduct the test. The commander was notified of the test requirements and tasked to provide pilots to participate in the test.

The test required 14 pilots in seven two man crews. Six crews would participate in the test with the seventh crew being an alternate. Each crew would fly the AH-1S helicopter and the new helicopter, the AH-64. A pilot would occupy either the front (copilot/gunner) or the back (pilot) seat throughout the test. A crew member would not interchange pilot stations. The AH-1S helicopter, which is the most advanced attack helicopter in the Army today, would be used as a base line helicopter to measure the combat effectiveness of the AH-64. Having the same crews flying both helicopters eliminated crew proficiency and experience as a testing parameter. The process allowed the test evaluators to hold crew proficiency constant and measure just the level of performance of the helicopters.

The crews were selected from a universe of 20 AH-1S pilots. Three pilots within the universe were eliminated because of their duty positions; the commander, executive officer, and operations officer. These individuals' duty position required their full attention, thus their participation in the test would be limited to those operational requirements implied by their position.

The commander and operations officer selected the 14 pilots from the remaining universe. They selected crews based on experience, ability, adaptability, combat sense, and maturity. They then selected crew members which complemented each other; pairing strengths and weaknesses in order to provide a typical attack helicopter crews.

The first pilot selection went forward on 15 September 1981 to the Operational Test and Evaluation Agency (OTEA) for approval. OTEA, the component agency responsible for evaluating the test results, worked in conjunction with the Training and Doctrine Command (TRADOC) and the AAH Project Manager (PM). These agencies evaluated the pilot selection submitted by the unit. The PM felt the crews did not have sufficient flight hours to handle the new helicopter and convinced OTEA and TRADOC to place a minimum hourly requirement of 1000 total flight hours and 500 AH-1 hours. Additionally, pressure from the Aviation Safety Center and the PM was placed on OTEA to change the single crew concept to dedicated AH-1S and AH-64 crews. The PM and Aviation Safety Center felt the crews could not adequately handle both helicopters and associated systems within operational safety constraints.

The new pilot requirements were sent to the unit on 1 October 1980. The commander was required to increase the total pilot universe from which he could draw, to accommodate the new requirement of 12 AH-1S and 12 AH-64 pilots. This was accomplished by adding 4 pilots from other units. Of the 24 pilots available, only nine met the hourly requirements. The commander, operations officer and battalion S-3 comprised three of the nine pilots. Because of their operational duties they were not considered. The commander decided to include the remaining six qualified pilots, and six additional pilots who he felt were totally capable of performing the mission with the same level of expertise as the qualified pilots.

A meeting was scheduled on 8 October 1980 to discuss the pilot selection and test design. Pilot selection was the major topic of discussion. The unit's pilot list was submitted for approval to TRADOC. Each pilot was discussed individually, using a performance profile designed by the unit commander. The list and profile were sent to OTEA and the PM for final approval. Both organizations rejected four of the pilots because of their flight hour deficiencies.

The commissioned officer platoon leader, whom the commander felt was an absolute necessity, was not approved. The commander felt that a commissioned aviator platoon leader qualified in the AH-64 was the only effective way to train the platoon as an effective combat fighting unit. Without this qualified platoon leader there would not be an effective leader who fully understood the system and how to tactically employ the system. This argument was also rejected and the unit was left four AH-64 pilots short.

Of the eight pilots approved by OTEA and the PM, two did not meet the minimum requirements. However, these pilots were acceptable because they were only 200 hours short of the total time requirement and exceeded the attack helicopter hourly requirement. The AH-1S pilots did not have to meet the hourly requirements and, thus, were filled from the remaining AH-1S pilots assigned to D Co.

The PM controlled the developmental test pilots who had conducted the first series of tests on the AH-64 and its related systems. He proposed that the remaining pilots come from this agency. TRADOC accepted this proposal; the remaining pilots would come from the Developmental Test and Training Detachment (DTTD). The final crew selection was approved 1 November 1980. D Company would provide eight pilots for the AH-64 and ten pilots for the AH-1S, and DTTD would provide four pilots for the AH-64 and two pilots for the AH-1S.

III. ANALYSIS OF TEST AVIATORS RELATIONSHIP TO THE AVIATION NORM

The question of whether the AH-64 and AH-1S aircrew members in the Advanced Attack Helicopter Test were typical of Army attack helicopter aircrew members with respect to flight hours was investigated. AH-1S aircrew members were typical of Army attack helicopter aircrew members while AH-64 aircrew members were considerably more experienced, and closely resembled instructor pilots and standardization instructor pilots.

This analysis was intended to answer the following question: How typical, or atypical, of Army attack helicopter pilots were the aircrew members who participated as crew members in the AH-64 and AH-1S in the Advanced Attack Helicopter Test? Since the point of the analysis was typicality, with respect to capability as attack helicopter pilots and copilot gunners, measures of experience in flying and fighting helicopters were considered appropriate.

Accordingly, data was gathered on the twelve AH-64 and twelve AH-1S aircrew members who participated in the Advanced Attack Helicopter Test, using the following measures.

Total Rotary Wing Flight Hours

Total Combat Rotary Wing Flight Hours

Total Rotary Wing Instructor Pilot Hours

Total Flight Hours in AH-1 Series Helicopter

Total Rotary Wing Flight Hours and Total Combat Rotary Wing Flight Hours were available from a sample of 222 AH-1 qualified aircrew members, gathered in 1978 from attack helicopter units at Fort Ord, Fort Bliss, Fort Hood, and Fort Bragg. Data on all the variables listed above were obtained from Flight Standardization Division, Directorate of Evaluation and Standardization, US Army Aviation Center, Fort Rucker. Additionally, Fort Rucker provided data on all the above variables for 292 instructor pilots in attack helicopters. This is virtually the total population of AH-1 series instructor pilots in the Army. Comparisons of the flight hour variables were then made among these four groups, utilizing non-parametric statistical tests since the distributions were far from normal.

Median and mean values of the flight hour variables for each of the four groups are presented in Appendix A, Table 1. From this table it can be seen that (based on median values) the AH-1S aircrew members have the fewest hours of all flight hour variables, followed in order by the 222 AH-1 qualified aircrew members (1978), the 292 instructor pilots (1981), and the AH-64 aircrew members. Further, it may be noted that the AH-1S aircrew members are similar to the 222 AH-1 qualified aircrew members (1978), while the AH-64 aircrew members are similar to the 292 instructor pilots (1981).

The results of the non-parametric statistical tests of the difference among the groups of aircrew members are shown in Appendix A. All of these statistical tests were Mann-Whitney two tailed tests, with the exception of those comparing the 222 AH-1 qualified aircrew members with the 292 instructor pilots, which were two-sample Kolmogorov-Smirnov two tailed tests. Since none of the statistical tests of differences among the groups of aircrew members were significant for total flight hours in the AH-1 series helicopters, these tests are not shown. The results of the statistical tests support the conclusion that the AH-64 aircrew members in the Advanced Attack Helicopter Test were essentially similar to the AH-1 series instructor pilots in Army attack helicopter units, while the AH-1S aircrew members were essentially similar to Army attack helicopter aircrew members. This support was clearcut in the cases of Total Rotary Wing Hours and Total Rotary Wing Instructor Pilot Flight Hours, and suggestive, but less clear cut in the case of Total Combat Rotary Wing Hours.

IV. EVALUATION OF AIRCREWS AND RESEARCH METHOD

This section will present an analysis of AH-64 crew performances observed during July 1981 through August 1981. The analysis is based on validated AH-64 engagement data provided by OTEA. The analysis considered only Force-on-Force data from trials which were determined to be representative (the data reflected what actually took place and the battle was not shaped by any outside influences. No major anomalies occurred which caused the battle to be improperly shaped) or marginally representative (the data reflected what actually took place, however, an anomally existed which may have caused the battle to be improperly influenced) by the testing agency. The data was partitioned into two groups according to whether it occurred before or after the instrumented training day on 30 July 1981. The reason for this division was due to the inconsistencies and deviations in tactical standing operating procedures (TSOP) by the test players prior to the instrumented training day. Trials conducted after 30 July 1981 were felt to be much more representative of attack helicopter tactical operations. Prior to this date crew coordination was adequate but team coordination, (the integration of multiple crews), was poor. This can be attributed to the lack of leadership within the AH-64 platoon. As noted earlier, OTEA had scrapped the idea of qualifying a platoon leader in the AH-64 because the individual did not meet the minimum flight hour requirement. In my opinion the problems with discontinuity and poor early performance are directly related to the absence of the qualified platoon leader.

Experience of the AH-64 crew members in the early trials was a deterrent instead of an advantage. Each crew felt they had the correct employment method and instead of working together they performed operations as individual crews fighting the battle instead of performing as a member of a larger team. This was not the case in later trials; crew performance increased proportionately, nor was this the case in the AH-1S base line platoon. The crew members in the base line platoon worked exceptionally well together and in the trials prior to 30 July 1981 they continually outperformed the AH-64 crew members. Unfortunately, time constraints precluded sufficient testing of the base line platoon crew members so test data on their performance level is based on exploratory trials and subjectivity. Because of the lack of adequate test data on the AH-1S base line platoon only the crew members of the AH-64 platoon will be evaluated. A point of interest would have been the analysis of the less experienced AH-1S platoon and the AH-64 platoon to determine the performance ratio. This point should be considered in future tests.

A. MEASURE OF PERFORMANCE AND EFFECTIVENESS OF THE AH-64 AIRCREWS

The measure of effectiveness used in the analysis of crew performance was selected to reflect the crew's ability to "put steel on target". Each autonomous simulated Hellfire launch was reviewed by the testing agency and an outcome was determined to be either an assessment against the target or a miss. The following ratio was used to show the success of the crew.

$$\text{Crew Performance Success Ratio} = \frac{\text{number of Autonomous Missile Assessments}}{\text{Total number of Autonomous Missile Launches}}$$

Two separate analyses were conducted to establish the multidimensional contingency table analysis used to analyze the missile launch success ratio. The first was conducted to investigate any possible differences between those trials which occurred before 30 July 1981 and those that occurred after that date, the two valleys, and the two crew types (those crews from DTTD and those from D. Co. 7th CAB). This analysis utilized only those trials which occurred during the day. The second analysis examined differences between valleys and crews for the night trials.

In both of the analyses the six aircrews were categorized as either DTTD (2) or D Co. 7th CAB (4) aircrews.

Included in the assessment total are those assessments made as a result of post trial review. Credit was given for an assessment during post trial if the onboard AH-64 video showed the correct conditions and sight picture for a successful engagement. Targets which continued to move after being assessed as "dead" in the real time casualty assessment (RTCA) process were also analyzed in post trial for inclusion into the success count. The table below shows the increase in assessments as a result of post trial review.

Table 4-1

HMMS Launch Assessments

	Total Launches	Real Time Assessments	Post Trial Assessments
Early Trials	75	24	11
Later Trials	96	38	31
Night Trials	91	27	46

The proportion of crew successes in later trials is significantly higher than the proportion of successes in early trials.

Table 4-2

HMMS Launch Assessments

	Successes	Failures
Early Trials	35	40
Later Trials	69	27

The data in the above table was summarized by combining successes and failures of all crews in each trial category. The reasons for the increase were directly attributed to changes made by the test players in response to leadership changes. The crews responded to their poor early performance by changing the engagement methods from singular crews to a team effort. The later trials portray a unit which conforms to a more realistic attack helicopter environment.

The proportion of DTTD crew successes in later trials and night trials was significantly higher than the D Co. crew successes in those same trials.

Table 4-3

HMMS Launch Success/Failure for Unit

	Later (Day)		Night	
	Successes	Failures	Successes	Failures
DTTD	45	7	39	4
D Co.	24	20	36	12

Again, the data in the above table was summarized by combining successes and failures for each crew's parent organization in each trial category. A probable explanation for the differences lies with the DTTD copilot gunners (CPG), each having 110 hours of TADS time versus the D Co. crews each having only 30 hours of experience with the TADS. Appendix D Figure 1 shows a graph depicting the relationship between performance and hours. Other reasons may be related to experience, combat time, Pilot Night Vision System (PNVS) time, and Time in Service (TIS). Initially, however, the performance between crews (DTTD and D Co.) in the early trials was less dramatic. This can be attributed directly to D Co.'s familiarity with the terrain and the tactical training they had undergone versus DTTD's sterile administrative flying and lack of current tactical training.

1. Results of Multidimensional Contingency Table Analysis of Trial, Valley and Crew (Day Trials)

The results of the analysis are presented in Appendix B, Table 1. Inspection of the results indicates several significant differences among factors. First is a difference between trials. As indicated in Appendix B, Table 2 the percent of successful launches is higher (72% vs. 47%) for those trials which occurred after 30 July 1981 than those trials which occurred prior to that date. The difference between valleys can be observed in Appendix B,

Table 3. There is a significantly higher percent of successful engagements in the Gabilan Valley than in the Nacimiento Valley (68% vs. 47%). The significant difference between the crews is presented in Appendix B, Table 4. DTTD crews had a success rate of 84% compared to the 46% achieved by D Co. crews. Of particular interest are the two significant interactions. The valley and crew interaction presented in Appendix B, Table 5, and Figure 1. It is evident that DTTD crews exhibited more of a difference between valleys (92% Gabilan vs. 50% Nacimiento) than did D Co. crews (47% Gabilan vs. 46% Nacimiento). An explanation for this difference is that the Gabilan provided better fields of fire than did the Nacimiento and that the DTTD crews had greater familiarity with the TADS. Trial vs. Valley vs. Crew interaction is presented in Appendix B, Table 6 and Figure 2. There is a larger indicated difference between trials for DTTD crews in the Nacimiento (20%, 30 July 1981 and before, vs. 48% after that date) and D Co. crews in the Gabilan valley (38%, 30 July 1981 and before, vs. 63% after that date) than found amongst DTTD crews in the Gabilan valley (100%, 30 July 1981 and before, vs. 91% after that date) and D Co. crews in the Nacimiento (43%, 30 July 1981 and before, vs. 48% after that date). Again, this difference can be directly attributed to DTTD's experience with the TADS and lack of

current tactical training. As noted earlier, DTTD crews did not work well during the early trials because of their inability to work as team members. This short-coming was overcome in later trials and their performance level increased accordingly. Whereas D Co. crews had worked as a unit for some time and thus were used to working together in tactical situations.

2. Results of Multidimensional Contingency Table Analysis of Trial, Valley and Crew (Night Trials)

The results of the analysis are presented in Appendix C, Table 1. Inspection of the results indicates several significant differences among factors. The first is a difference between valleys, as indicated in Appendix C, Table 3. The percent of successful launches is higher (91% vs. 69%) in the Nacimiento valley than in the Gabilan valley. Also present is a valley versus crew interaction. This is presented in Appendix C, Table 2, and Figure 1. It is evident that the D Co. crews exhibited more of a difference between valleys (56%, Gabilan vs. 96%, Nacimiento) than did the DTTD crews (100%, Gabilan vs. 88%, Nacimiento). Again, the reason for the greater success of the DTTD crews can be directly related to their experience with the TADS and the AH-64.

B. ANALYSIS OF AUTONOMOUS HELLFIRE MISSILE SYSTEM

This analysis determined the relationship between the percent of successful simulated autonomous HMMS launches for each of six aircrews and various flight crew parameters. The number of successful simulated autonomous HMMS launches were calculated for each of the six aircrews (2 of the crews are DTTD and 4 are D Co.). Only those trials which occurred after 30 July 1981 were used in this calculation. From these tabulations a "percent of simulated autonomous HMMS launches which were successful" ratio was obtained for each crew. This ratio was then correlated using simple linear regression with various flight crew parameters; (for both the pilot and copilot gunner), total flight time, total flight time in attack helicopters (AH-1 series), total flight time in the AH-64, total combat flight time, total instructor pilot (IP) or standardization instructor pilot (SIP) flight time, and average test scores in ground school. Each parameter was correlated with successful autonomous HMMS launches to determine if there are measures which best describe the characteristics required to perform pilot or copilot gunner duties in the AH-64. Those analyses which yielded relevent results are discussed in Chapter 5 and in Appendix D.

V. ANALYSIS OF CREW PERFORMANCE

This section will draw on the performance levels of each aircrew and the relationship of their experience with their performance to determine any significant correlation between crew performance and individual data. The table below shows the combined results of the data used in evaluating crew performance, this data is compiled in Appendix B.

Table 5-1

Crew HMMS Launch Success Ratio

Crew	Success Ratio	Performance Peak
1	37/41 (.90)	1
2	47/54 (.87)	2
3	19/35 (.54)	5
4	10/14 (.71)	3
5	20/29 (.69)	4
6	4/13 (.31)	6

The proportion of crew successes in the Gabilan valley during the later trials was significantly higher than the proportion of crew successes in the Nacimiento valley.

Table 5-2

Crew HMMS Launches for Valley

	Later (Day)		Night	
	Successes	Failures	Successes	Failures
Gabilan	51	11	25	10
Nacimiento	18	16	43	12

The table above shows the combined successes and failures for all crews for a particular valley. There was not a significant difference in crew successes between valleys during the night trials. A possible explanation for this difference might be explained by the tables below.

Table 5-3

Type HMMS Launch

Later Trials

	Total Autonomous Launches	Total Remote Launches
Gabilan	62	15
Nacimiento	34	49

Table 5-4

Autonomous HMMS Launch by Crew

Later Trials

	Total DTTD Autonomous Launches	Total D Co. Autonomous Launches
Gabilan	43	19
Nacimiento	9	25

The major differences can be explained by the valley's physical disposition; the Nacimiento is heavily wooded, whereas the Gabilan is open rolling terrain. The Nacimiento lends itself to remote shots and the Gabilan to autonomous shots.

There was a significant difference in the types of launches between the two valleys. This was possibly due to the Gabilan valley offering good autonomous flanking shots along the entire western edge of the valley, whereas the Nacimiento valley was more conducive to air and ground remote launches. Additionally, the proportion of DTTD launches was significantly higher in Gabilan valley versus the Nacimiento valley. With the DTTD crews firing a very high success ratio this might affect the results in the Nacimiento since the DTTD autonomous opportunities in that valley were significantly less. Further analysis of DTTD launches reinforced the explanation of the Gabilan valley being used more for autonomous shots and the Nacimiento valley for remote shots. The table below shows the DTTD breakout.

Table 5-5

DTTD Later Trials

	Autonomous Launches	Remote Launches
Gabilan	43	1
Nacimiento	9	25

The use of remote launches by DTTD can be directly attributed to the copilot-gunner. The two DTTD copilot-gunners were the Army's test pilots during Developmental Testing. They worked exclusively with the AH-64 and its related systems for a year prior to the test. Their familiarity with the system provided a distinct advantage to their employment concepts and success ratio.

A. COPILOT GUNNER ANALYSIS OF MOE

Since there was no significant difference between the later trials and the night trials, based upon the MOE used, only the copilot gunner characteristic data will be considered for association with the MOE. The copilot gunner has probably 95% control over whether a launch will be successful. Even though the pilot has a demanding workload in flying at night, once a firing position has been occupied, the launch cycle rests with the copilot gunner. Therefore, the correlations developed in this section focus entirely on the copilot gunners. A non-parametric test was chosen to measure the degree of association between the performance ranks of the crew with various copilot gunner data such as experience, education, and training scores. The Spearman rank correlation coefficient (r_s) was used to measure this degree of association. It can vary from +1.0 to -1.0, with numbers close to +1.0 indicating a strong positive association and numbers close to -1.0 a strong negative association. Numbers close to 0 indicate no association. In addition, a test of the significance of the Spearman correlation coefficient was made for each conclusion using $\alpha = .10$. Even though the sample size of 6 is small, this non-parametric test is designed for such samples. Appendix D provides a detailed correlation analysis of all parameters.

Crew performance and copilot gunner time in service are significantly associated with a correlation coefficient $r_s = .885$.

Table 5-6

CPG Time in Service (TIS)

Crew	Crew Performance Rank	CPG ITS (months)	CPG TIS Rank
1	1	157	2
2	2	185	1
3	5	48	5
4	3	108	4
5	4	147	3
6	6	42	6

The data suggests a fairly strong positive association between the performance MOE and the time in service of the CPG. The TIS rank, also, significantly correlates with r_s = 1.0 or a perfect positive correlation, with CPG months on flying status. This would tend to suggest that more experienced aviators perform better as copilot gunners than less experienced, which is a very common sense type result. However, it must be noted that the experience of the DTTD copilot gunners will bias the outcome of the test results and a more interesting analysis would be to evalute the performance of the D Co. crews separately.

Another result related to the experience factor is the association between performance and the number of months a CPG has been assigned to an attack helicopter unit. As expected, there exists a significant positive correlation of .828 between the performance data and the number of months a copilot-gunner has been assigned to an attack helicopter unit. This would be as expected since longer TIS aviators will probably have more opportunities for time in attack helicopter units than low TIS aviators. The following table shows the rank of CPG's in relationship to total time assigned to attack helicopter units.

Table 5-7

CPG Months Assigned AH Units

Crew	Crew Performance	CPG Months Assigned to AH	CPG Months Assigned to AH Rank
1	1	130	2
2	2	173	1
3	5	26	6
4	3	96	4
5	4	140	3
6	6	28	5

Crew performance and the amount of CPG flight hours during the last 12 months are not associated. ($r_s = -.028$)

Table 5-8

CPG Total Flight Hours Last 12 Months

Crew	Crew Performance	CPG FLT Hrs	FLT Hrs Rank
1	1	95	5
2	2	126	3
3	5	130	2
4	3	113	4
5	4	158	1
6	6	45	6

This is a misleading result; the DTTD copilot gunners were involved in the AH-64 developmental testing during the preceding 12 months. Their entire flight experience for that time was in the AH-64; whereas, the D Co. copilot gunners were flying the AH-1S. Crew performance and CPG point target weapon system (PTWS) exam results are significantly correlated with r_s = .985.

Table 5-9

CPG PTWS Exam Average

Crew	Crew Performance Rank	CPG PTWS Exam Avg	CPG PTWS Exam Rank
1	1	100	1
2	2	98.5	2.5
3	5	91.5	5
4	3	98.5	2.5
5	4	94.8	4
6	6	89.8	6

An almost perfect positive correlation exists among this data. The PTWS exam average was computed from the results of the contractor training program examinations 3 and 4 which dealt exclusively with the Target Acquisition and Detection System (TADS), switchology, symbology, and the Integrated Helmet and Display Sight system (IHADSS) which are crucial to the operation of the Hellfire system. It should be noted that the copilot-gunners in Crews 1 and 2 had received extensive training and experience previously during developmental testing of the helicopter. Crew performance and copilot gunner civilian education are not significantly correlated. (r_s = .521)

Table 5-10

CPG Civilian Education

Crew	Crew Performance Rank	CPG Civ Ed (yrs)	CPG Ed Rank
1	1	14	3.5
2	2	14	3.5
3	5	13	5
4	3	18	1
5	4	16	2
6	6	12	6

Although the correlation coefficient showed a positive correlation, it was not significant for the size of the sample. However, the significance test was very close to $\alpha = .1$ and consideration should be given to this factor if a larger sample can be obtained. Crew performance and copilot gunner terrain flight hours are not significantly ocrrelated. ($r_s = .542$)

Table 5-11

CPG Total Terrain Flight Hours

Crew	Crew Performance Rank	CPG Terrain Flt Hrs	CPG Terrain Hrs Rank
1	1	600	4
2	2	1700	1
3	5	700	3
4	3	1200	2
5	4	500	5
6	6	450	6

This result is much like the previous one in which the coefficient is positive and the significance level was close to .1, but not in the rejection region. However, consideration probably should be given to this factor since it is related to TIS and experience level.

VI. CONCLUSIONS

The six crews which constituted the AH-64 test base do not mirror the typical Army aviator. The two DTTD crews (crew 1 and 2) have been involved with the AH-64 and its related systems from the beginning of the program. These crews are highly experienced aviators whose performance should, by design, be better than the average Army crew. In fact, each DTTD crew member is an Instructor Pilot or Standardization Instructor Pilot with an average total flight time of 4100 hours and an average total AH-1 series flight time of 2500 hours. As noted in Appendix A, Table 1 these hours far exceed the AH-1 Qualified pilots and the AH-1 Instructor Pilot community.

Discounting the DTTD crews, the D Co. crews provide a much more interesting analysis from which to choose crew members for the AH-64 helicopter. Their average total flight time is 1982 hours and their average total AH-1 flight time is 686 hours which places them between the AH-1 qualified community and the Instructor Pilot community. D Co. copilot gunners average total flight time is 847 hours and their average total AH-1S flight time is 680 hours. The copilot gunner hours are less than that of the Army AH-1 qualified community.

Crews 4 and 5 consisted of a maintenance officer, a safety officer, an instructor pilot and an operational pilot. This is a strange mix for crews but does bring into light an interesting analogy. These aviators do not mirror the tactical and flying experience of the average Army attack helicopter pilot. In a typical attack helicopter unit, the maintenance officer and safety officer seldom fly in tactical training situations. They are more apt to perform administrative missions which correspond to their duty positions. These pilots were the copilot gunners for crews 4 and 5, whose performance ranks were 3 and 4 respectively.

Crew 3 consisted of an instructor pilot in the back seat and a 700 hour pilot as the copilot gunner. With the experience of the back seater and the lack of experience of the copilot gunner they were able to move to their firing positions without being detected but had difficulty in the engagement sequence. Crew 3 is probably the most typical crew in the test and they achieved a 54% success ratio being ranked 5.

Crew 6 consisted of a 3000 hour back seater who had less than 500 hours AH-1 attack helicopter time and in fact had spent the majority of his career flying CH-47 heavy lift helicopters. The copilot gunner was the lowest time aviator with less than 600 hours total time. With the lack of experience of both pilots their performance rank was 6 with a success ratio of 31%.

What is important from this brief description of the D Co. pilot history of the crews is, no matter what their prior experience level was, they were able to perform within the design constraints of the system. They performed to the level expected commensurate with their experience. Since D Co. crews provide a much better picture of Army aviation and aviators, and their performance is within the design constraints, the selection of pilots to fly the AH-64 does not have to be tied to a magical number of time in service, total flight time, or total attack helicopter time. Rather to the individual's ability to perform within an attack helicopter unit. The necessary ingredients to successfully operate the AH-64 is the ability to think of the machine as an extension of the aviator. It is true, as the test proved, the greater the experience and exposure to the system the better the performance level. However, the Army does not have the luxury of having a multitude of DTTD experienced aviators; hence, our choice must be made from the population on hand. As indicated, D Co. crews are typical of that population and thus provide a basis for the selection process.

With this in mind we can conclude that aircrew members should be AH-1 qualified pilots who have performed well in attack helicopter units. This will provide a basis for the tactical employment experience necessary to effectively employ the AH-64. It is also apparent that the copilot gunner should be the more experienced crew member; which is in direct contradiction to the current manning process of attack helicopter crews.

APPENDIX A

AVIATOR COMPARISON TABLES

Table 1

	Total Hel Flt Hrs		Total Combat Hel Flt Hrs	
	Med	Means	Med	Means
AH-1S crew N=12	1050	1753	----	342
AH-1 Qual Aircrew's 1978, N=222	1427	1452	----	409
AH-1 IP/SIP 1981, N=292	2614	2662	497	565
AH-64 aircrew N=12	2854	3332	642	615

Table 1 - Continued

	Total IP Hel Flt Hrs		Total Flt Hrs AH-1 Hel	
	Med	Means	Med	Means
AH-1S Crew N=12	22	301	450	998
AH-1 Qual Aircrews 1978, N=222	----	----	----	----
AH-1 IP/SIP 1981, N=292	577	769	1010	1114
AH-64 Aircrew N=12	657	983	1123	1580

Table 2

Total Flight Hours Comparison

Total Rotary Wing Flight Hours

	AH-1S Aircrew	AH-1-Qual Aircrew	IP/SIP 1981	AH-64 Aircrew
AH-1S Aircrew	-----			
AH-1-Qual Aircrew	N.S.	-----		
IP's & SIP's	**	***	-----	
AH-64 Aircrew	*	***	N.S.	-----

N.S. Not significant, $p > .05$

* Significant, $.01 < p < .05$

** Significant, $.001 < p < .01$

*** Significant, $p < .001$

Table 3

Total Combat Flight Hours Comparison

	AH-1S Aircrew	AH-1-Qual Aircrew	IP/SIP 1981	AH-64 Aircrew
AH-1S Aircrew	-----			
AH-1-Qual Aircrew	N.S.	-----		
IP's & SIP's, 1981	*	***	-----	
AH-64 Aircrew	N.S.	N.S.	N.S.	-----

N.S.	Not Significant,	$p > .05$
*	Significant,	$.01 < p < .05$
**	Significant,	$.001 < p < .01$
***	Significant,	$p < .001$

Table 4

Total Rotary Wing Instructor Pilot Flight Hours

	AH-1S Aircrew	IP's & SIP's 1981	AH-64 Aircrew
AH-1S Aircrew	-----		
IP's & SIP's, 1981	***	-----	
AH-64 Aircrew	*	N.S.	-----

N.S.	Not Significant,	$p > .05$
*	Significant,	$.01 < p < .05$
**	Significant,	$.001 < p < .01$
***	Significant,	$p < .001$

APPENDIX B

MULTIDIMENSIONAL CONTINGENCY TABLE ANALYSIS (DAY TRIALS)

Table 1

Simulated HMMS Autonomous Launches (day trial)

Information	MDIS (a)	df (e)	% Var	α (b)
Base Hypothesis	45.663	7		.0000
Trial	11.272	1	24.71	.0008
Goodness-of-fit	34.357	6	24.71	.0008
Valley	8.446	1	18.51	.0037
Goodness-of-fit	25.911	5	43.32	
Crew	13.411	1	29.29	.0003
Goodness-of-fit	12.501	4	72.61	
Trial vs Valley	.294	1	.64	.5874
Goodness-of-fit	12.206	3	73.25	
Trial vs Valley	.010	1	.02	.9194
Goodness-of-fit	12.196	2	73.27	
Valley vs Crew	6.962	1	15.26	.0083
Goodness-of-fit	5.234	1	88.53	
Trial/Crew/Valley	5.229	1	11.46	.0222
Goodness-of-fit	.005	0	99.99	

(a) The MDIS is the minimum Discrimination information statistic which is distributed asymptotically as a chi-square statistic.

(b) α is the critical level of the test, the level at which the null hypothesis may be rejected.

(c) The hypothesis may be stated: The data is uniformly distributed.

(d) The goodness-of-fit term describes how well the model predicts the values in the table.

(e) DF indicated the degrees of freedom used in evaluating the MDIS statistic.

(f) The data compiled in this table consists of all valid successful simulated autonomous HMMS launches for day trials.

Table 2

Data for Table 1 presented in both numerical count and percent of total calculated across trial.

Trial	30 July 1981 and Before		After 30 July 1981	
	number	percent	number	percent
Success	47	47	69	72
Failure	40	53	27	28
Total	74	100	96	100

Table 3

Data for Table 1 presented in both numerical count and percent of total calculated across valley

Valley	Gabilan		Nacimiento	
	number	percent	number	percent
Success	76	68	28	47
Failure	35	32	32	53
Total	11	100	60	100

Table 4

Data for Table 1 presented in both numerical count and percent of total calculated across crew

Crew	DTTD		D Co.	
	number	percent	number	percent
Success	56	84	48	46
Failure	11	16	56	54
Total	67	100	104	100

Table 5

Data for Table 1 presented in both numerical count and percent of total, broken down by Valley and Crew

Valley	Gabilan			
Crew	DTTD		D Co.	
	number	percent	number	percent
Success	49	92	27	47
Failure	4	8	31	53
Total	53	100	58	100

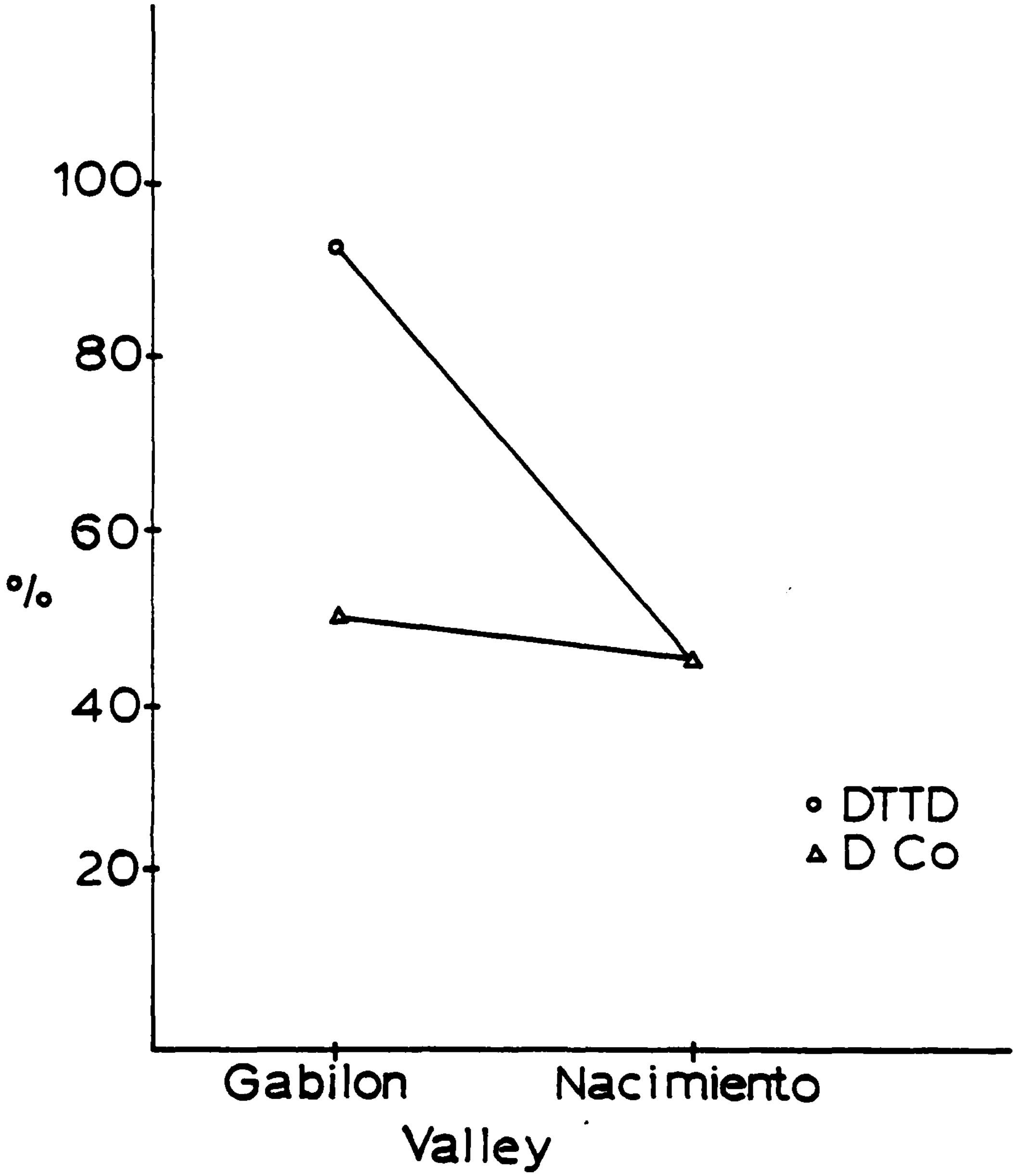
Valley	Nacimiento			
Crew	number	percent	number	percent
Success	7	50	21	46
Failure	7	50	25	54
Total	14	100	46	100

Table 6

Data for Table 1 presented in both numerical count and percent of total broken down by Trial, Valley, and Crew

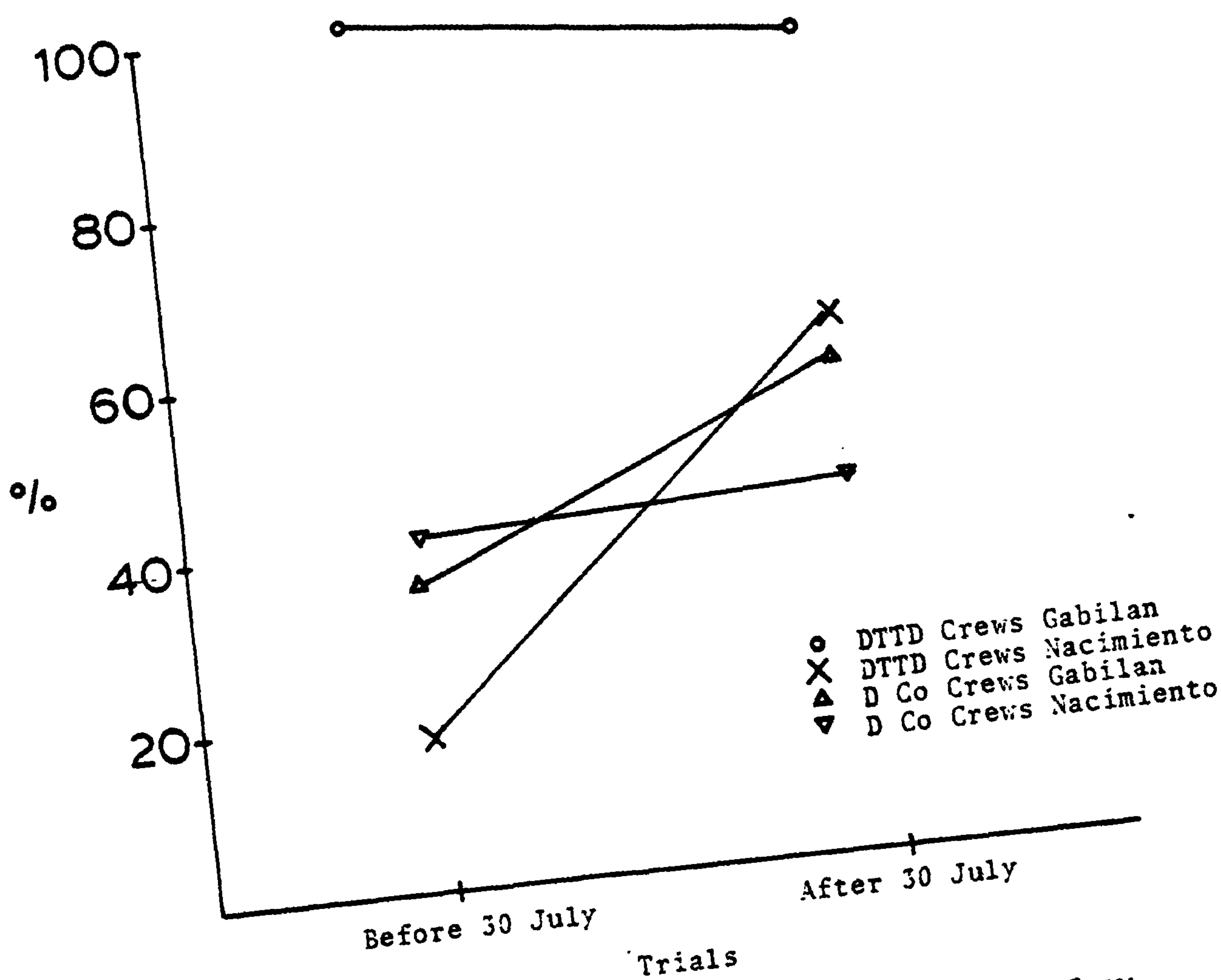
Trial	30 July 1981 and Before			
Valley	Gabilan			
Crew	DTTD		D Co.	
	number	%	number	%
Success	10	100	15	38
Failure	0	0	24	62
Total	10	100	39	100
Valley	Nacimiento			
Success	1	20	9	43
Failure	4	80	12	57
Total	5	100	21	100
	After 30 July 1981			
Valley	Gabilan			
Success	39	91	12	63
Failure	4	9	7	37
Total	43	100	19	100
Valley	Nacimiento			
Success	6	67	12	48
Failure	3	33	13	52
Total	9	100	25	100

Figure 1



Representation of the Valley versus Crew interaction and successful simulated AMMS launches percentage

Figure 2



Representation of the Trial versus Valley versus Crew interaction and percent of simulated autonomous HMMS successful launches as indicated in Table 1

APPENDIX C

MULTIDIMENSIONAL CONTINGENCY TABLES (NIGHT TRIALS)

Table 1

Multidimensional contingency table analysis of valley by crew and successful autonomous HMMS launches for all valid night trials

Information	MDIS (a)	df (e)	% Var	α (b)
Base Hypothesis	17.993	3		.00044
Valley	6.805	1	37.82	.0091
Goodness-of-fit	11.189	2	37.82	
Crew	1.941	1	10.79	.1635
Goodness-of-fit	9.248	1	48.61	
Valley vs Crew	9.242	1	51.36	.0024
Goodness-of-fit	.006	0	99.97	
Trial/Crew/Valley	5.229	1	11.46	.0222
Goodness-of-fit	.005	0	99.99	

(a) The MDIS is the minimum Discrimination information statistic which is distributed asymptotically as a chi-square statistic.

(b) α is the critical level of the test, the level at which the null hypothesis may be rejected.

(c) The hypothesis may be stated: The data is uniformly distributed.

(d) The goodness-of-fit term describes how well the model predicts the values in the table.

(e) DF indicated the degrees of freedom used in evaluating the MDIS statistic.

(f) The data compiled in this table consists of all valid successful simulated autonomous HMMS launches for night trials.

Table 2

Data for Table 1 presented in numerical count and percent of total, broken down as Trial by Valley and Crew

Valley	Gabilan			
Crew	DTTD		D Co.	
	number	percent	number	percent
Success	11	100	14	56
Failure	0	0	11	44
Total	11	100	25	100

Valley	Nacimiento			
Crew	DTTD		D Co.	
	number	percent	number	percent
Success	28	88	22	96
Failure	4	12	1	4
Total	32	100	23	100

Table 3

Data for Table 1 presented in numerical count and percent of the total, broken down for valley

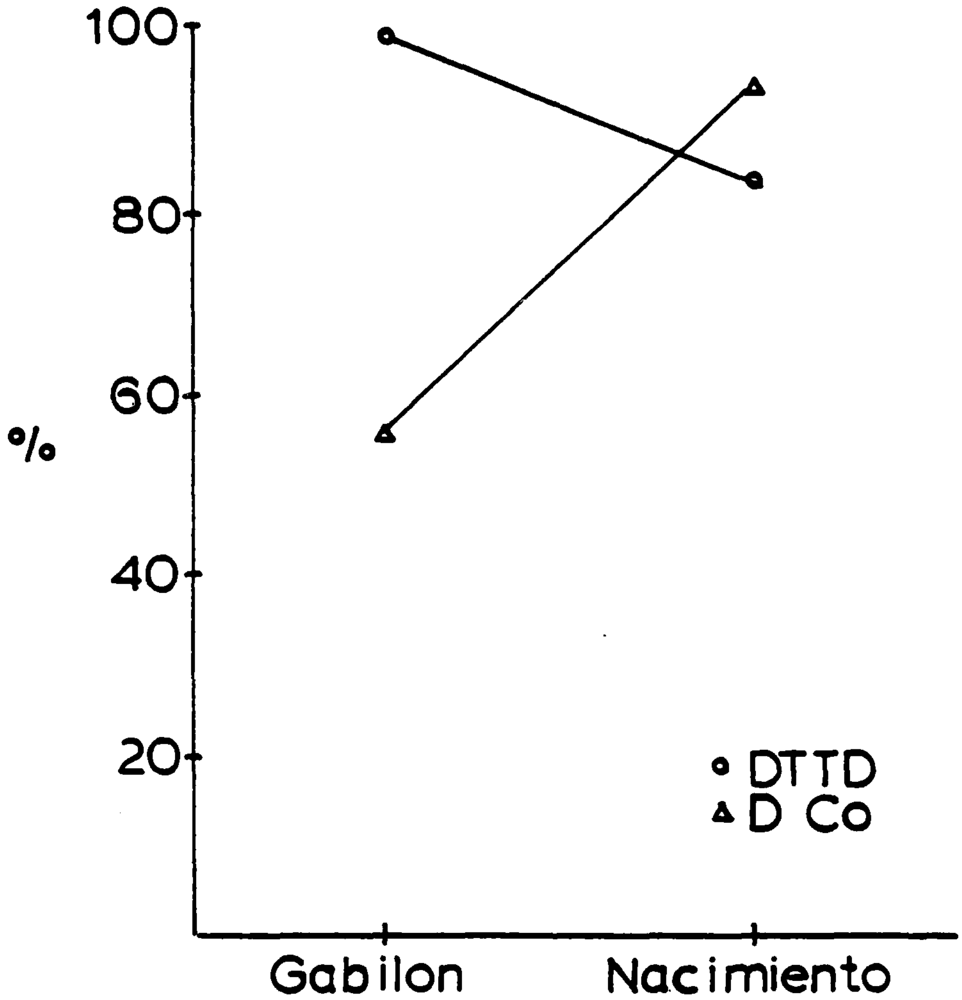
Valley	Gabilan		Nacimiento	
	number	percent	number	percent
Success	25	69	50	91
Failure	11	31	5	9
Total	36	100	55	100

Table 4

Data for Table 1 presented in numerical count and percent of the total, broken down by crew

Crew	DTTD		D Co.	
	number	percent	number	percent
Success	39	91	36	75
Failure	4	9	12	25
Total	43	100	48	100

Figure 1

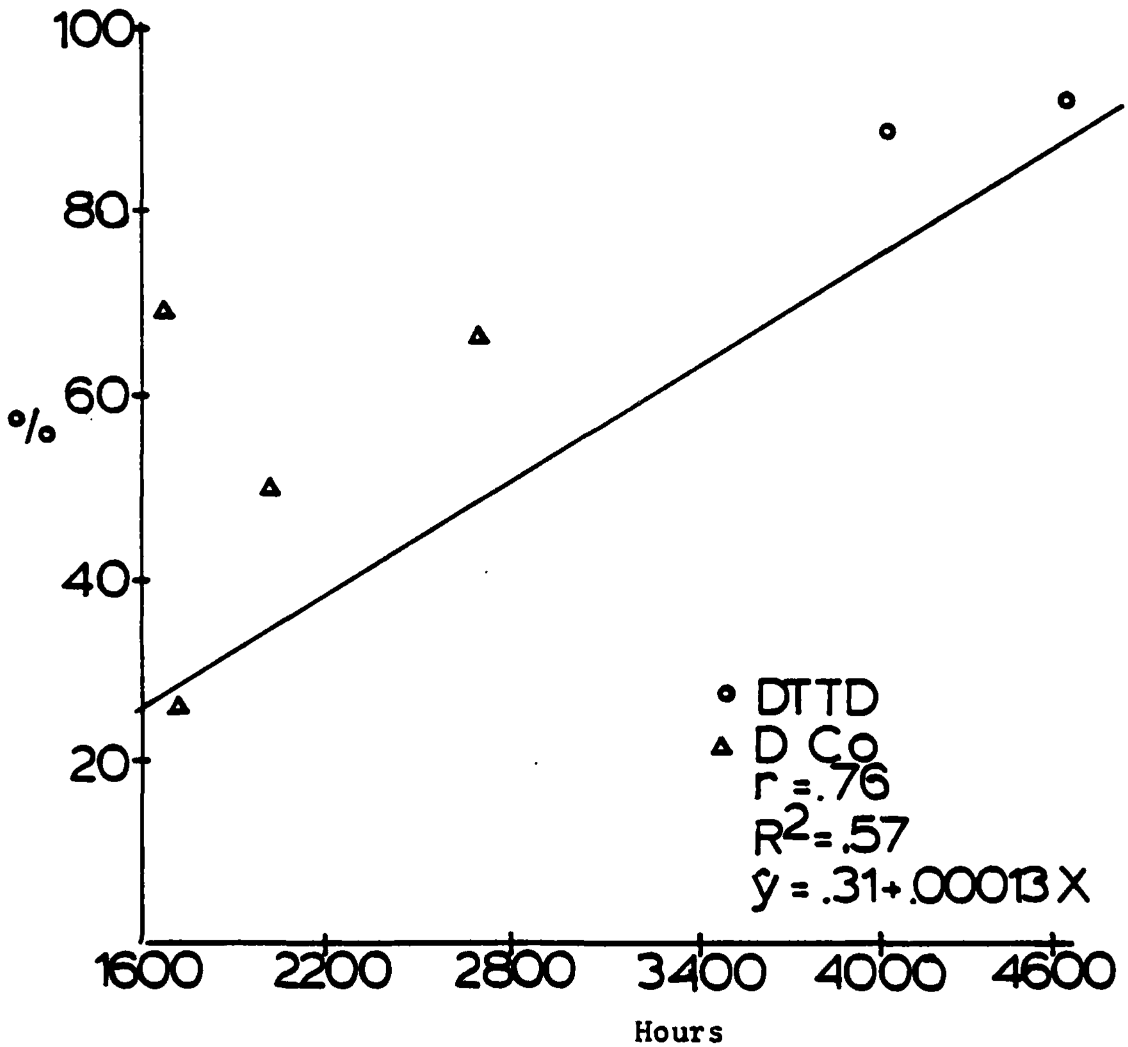


Representation of the Valley versus Crew interaction and percent of simulated autonomous HMMS successful launches as indicated in Table 1

APPENDIX D

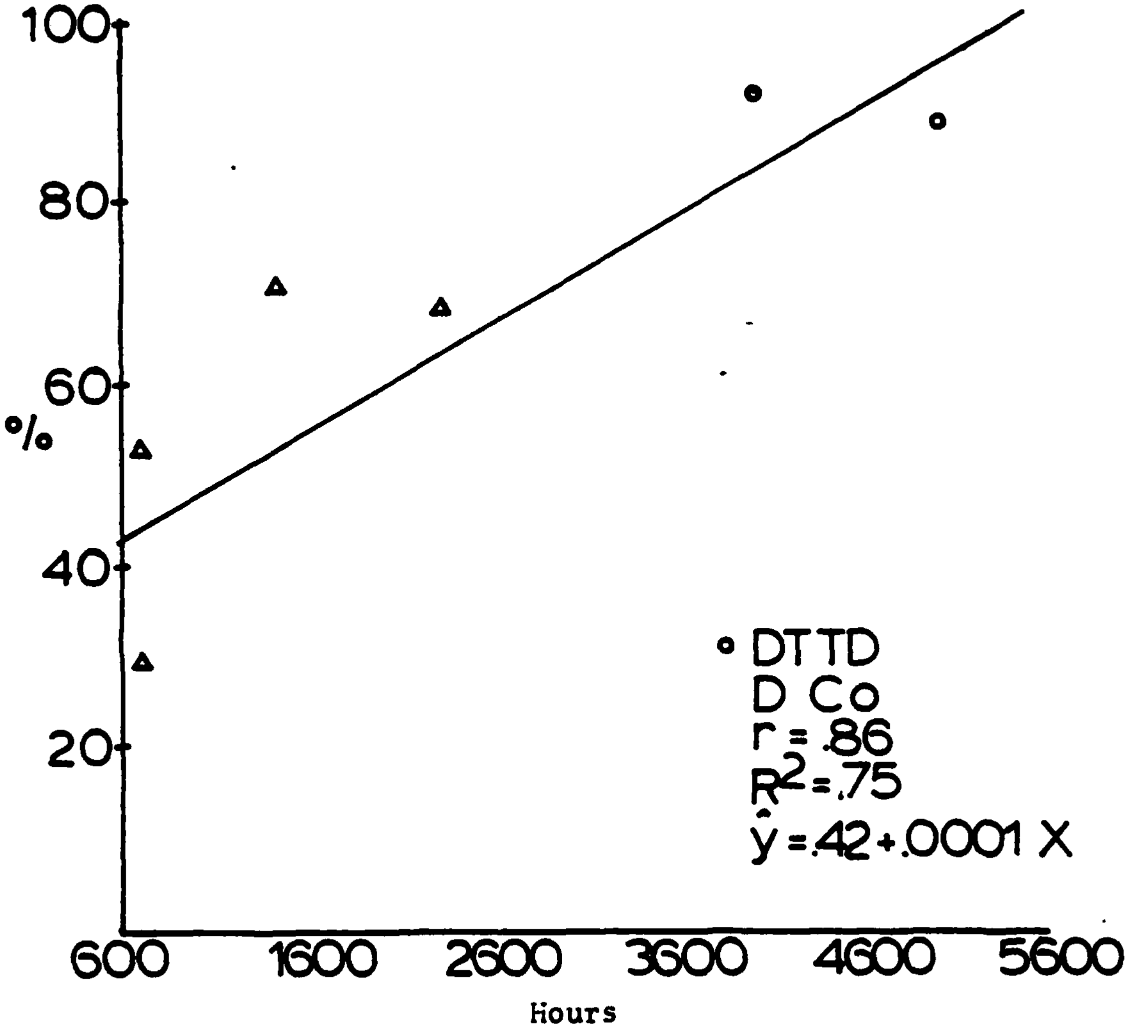
CORRELATION TABLES

Figure 1



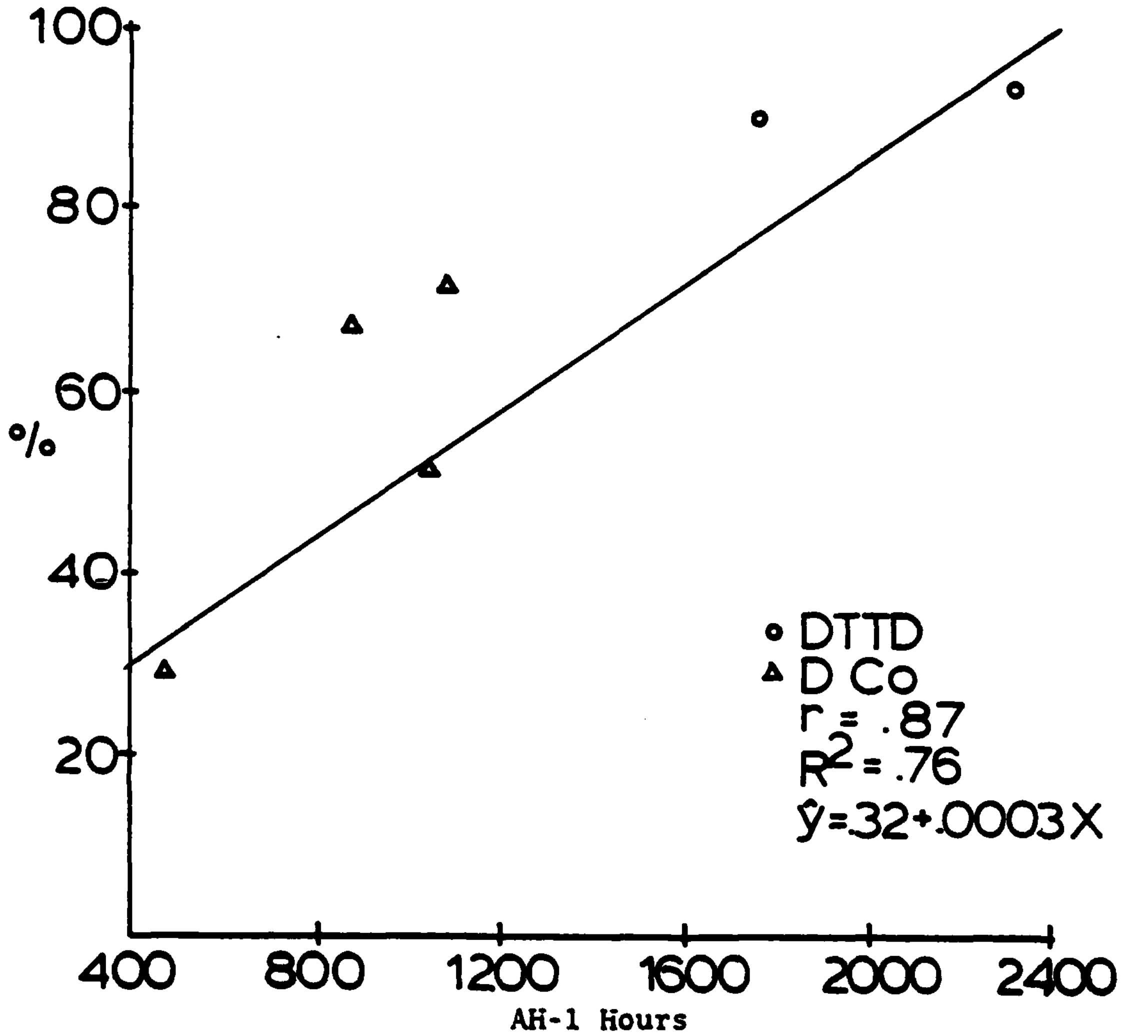
Relationship between average total crew flight hours and % of successful simulated autonomous HMMS launches

Figure 2



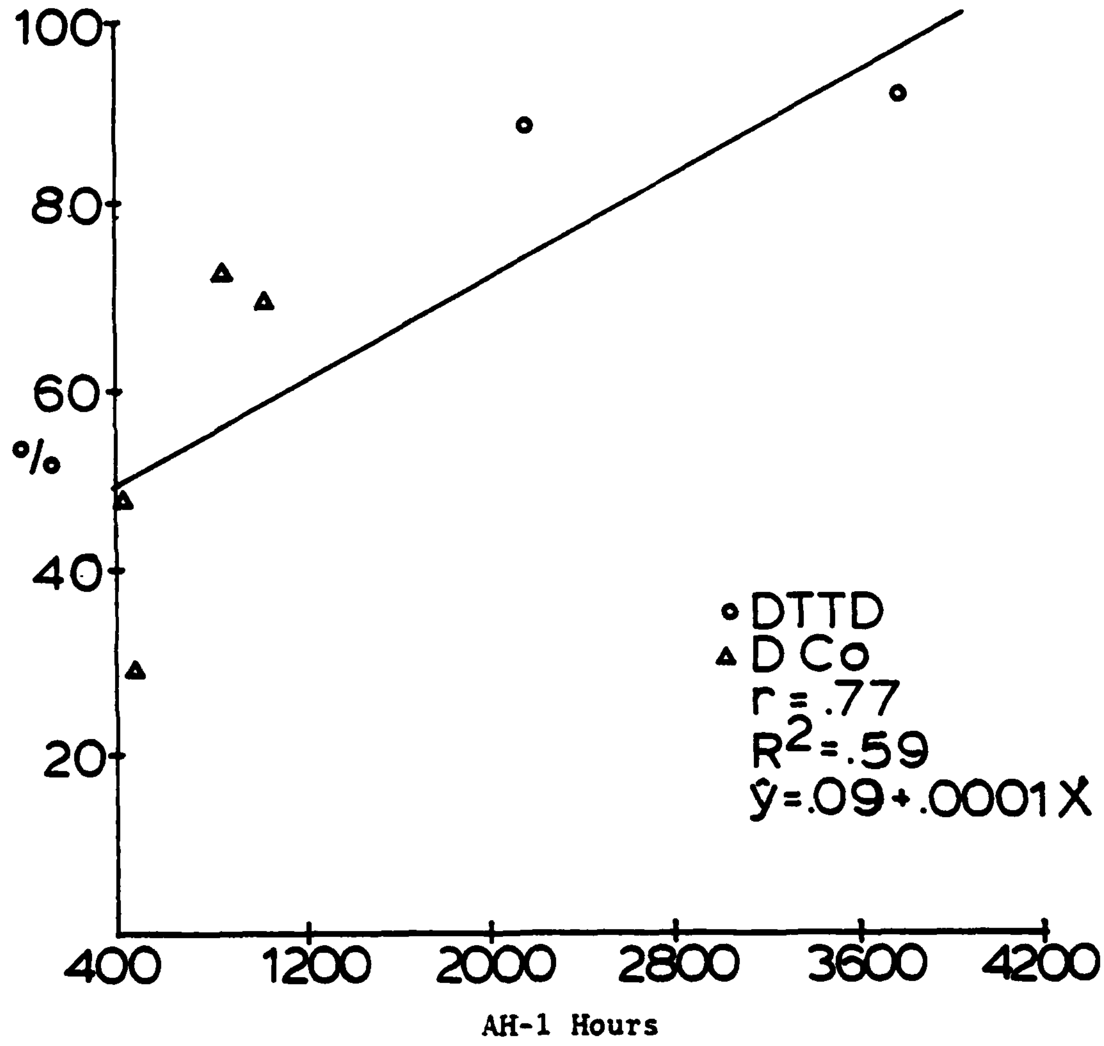
Relationship between copilot gunner total flight hours and % of successful autonomous HMMS launches

Figure 3



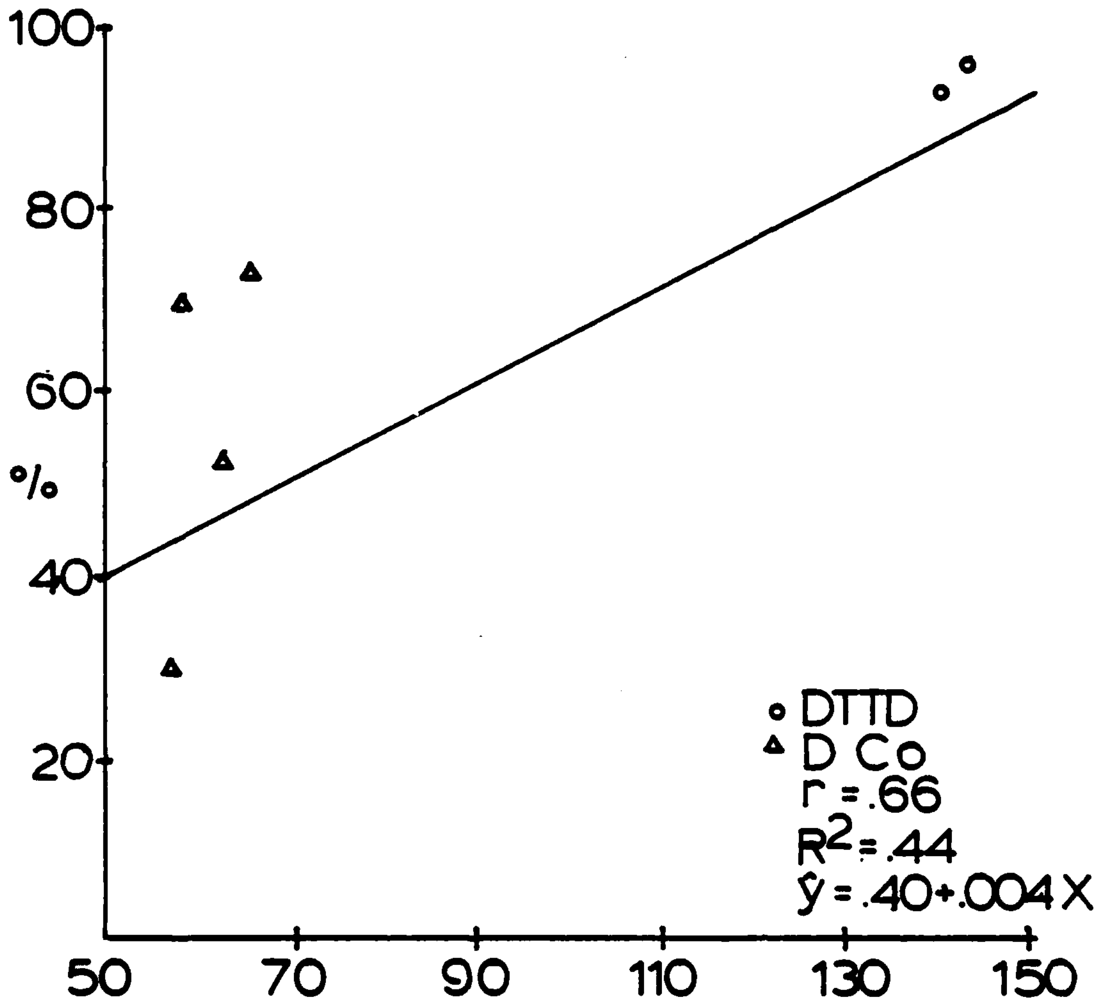
Relationship between the pilots total flight hours in attack helicopters (AH-1) and % of HMMS successful simulated autonomous launches

Figure 4



Relationship between the copilot gunners total flight hours in AH-1 series attack helicopters and % of successful simulated autonomous HMMS launches

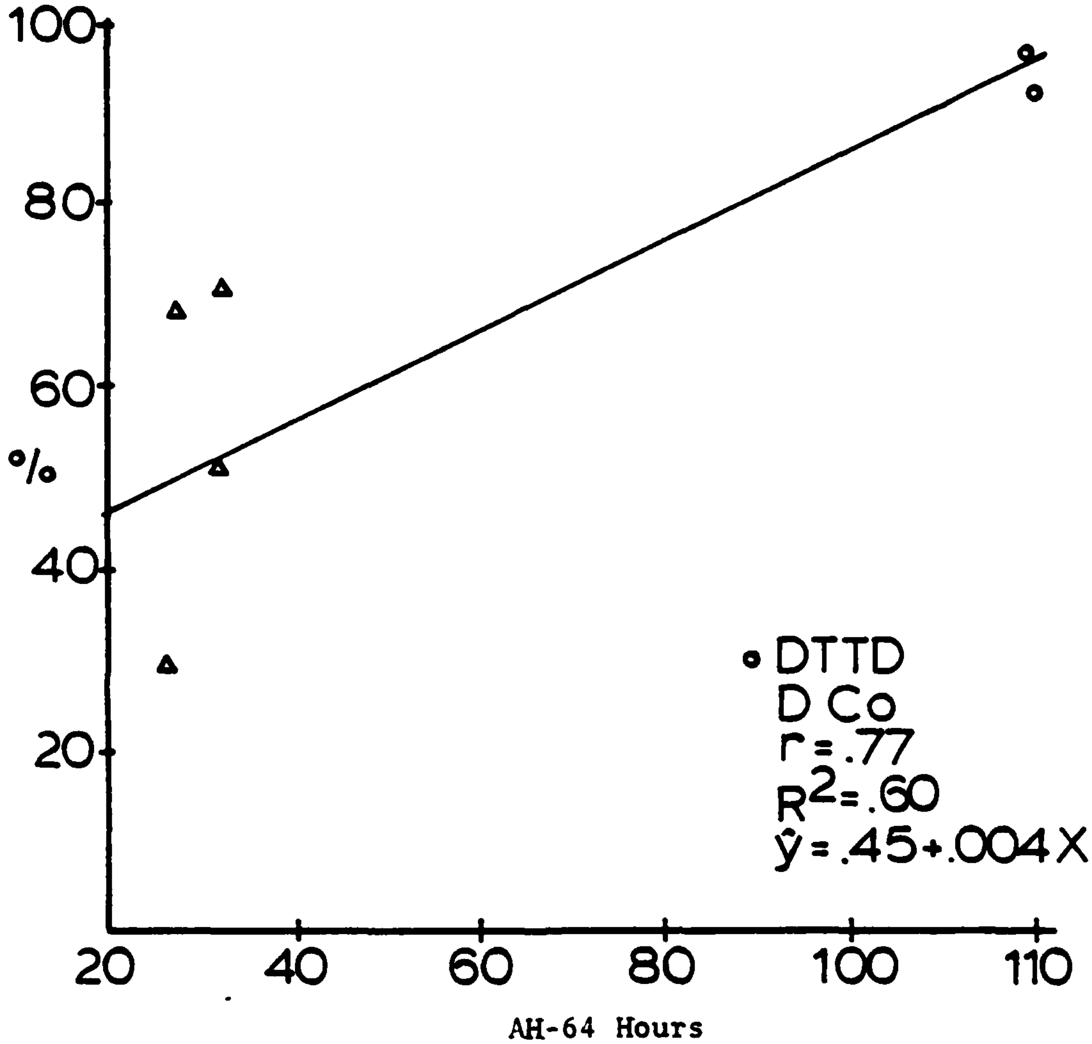
Figure 5



AH-64

Relationship between total crew flight hours in the AH-64 prior to the test and the % of successful simulated autonomous HMMS launches

Figure 6



Relationship between copilot gunner total flight hours in the AH-64 and % of successful simulated autonomous HMMS launches

APPENDIX E

CREW PERFORMANCE DATA SUMMARY

		Crew					
		DTTD			D Co.		
Trial	Valley	1	2	3	4	5	6
024	N					0/2	
026	G				1/3	0/1	
101	G		4/4				3/4
103	G	6/6				5/8	
108	G			4/5			
109	G						4/6
110	N	1/2	0/3				
111	N				5/6	2/7	
112	N					1/4	2/2
113	G						2/9
115	N	4/5		1/2	0/1		
116	N		2/4			2/4	0/1
117	N			2/8	7/9		
118	G		5/5				2/7
119	G	5/7			1/1		
120	G	15/16		4/6			
123	G		14/15			5/5	
126	G			6/9		5/9	
127	G		12/12				2/5
129	N	13/13	14/18		2/3		
130	N			6/10		8/11	

Legend:

(1) Data reflects MOE of # Success/# Success + # Failures

(2) Early trials are 113 and before and later trials are after trail 113.

(3) N denotes Nacimiento valley

(4) G denotes Gabilan valley

APPENDIX F

CHI-SQUARED TEST EXAMPLE

1. Hypothesis

   H_0 - There is no difference between the proportion of crew successes in the early trials versus the later trials.

   H_1 - The proportion of successes in later trials is greater than in the early trials.

2. Data

	Successes	Failures
Early Trials	A_{40}	B_{33}
Later Trials	C^{69}	D_{27}

$N = A+B+C+D = 169$

3. Signficance Level - Let $\alpha = .1$

4. Computations[1]

$$x^2 = \frac{N(|AD - BC| - N/2)^2}{(A+B)\ (C+D)\ (A+C)\ (B+D)} = 4.56$$

   Prob $(x^2 \geq 4.56/H_0)$ = Prob $< .05$

5. Decision

   Since Prob $< \alpha = .1$ Reject H_0 in favor of H_1

6. Conclusion

   Therefore the proportion of successes in later trials is greater than in the early trials at the .1 level of significance.

APPENDIX G

SPEARMAN RANK CORRELATION COEEFICIENT

1. Hypothesis

   H_0 - Crew performance and copilot gunner time in service are not associated.

   H_1 - Crew performance and copilot gunner time in service are associated positively.

2. Data

Crew	Performance Rank (x)	CPG TIS RANK (y)	Diff (d)	$Diff^2$
1	1	2	1	1
2	2	1	1	1
3	5	5	0	0
4	3	4	1	1
5	4	3	1	1
6	6	6	0	0

3. Significance Level - .1

4. Computations $\Sigma x^2 = \frac{N^3 - N}{12} - \Sigma\frac{t^3 - t}{12} = \frac{6^3 - 6}{12} - 0 = 17.5$

   $\Sigma y^2 = 17.5$

   Spearman Rank Correlation Coefficient $r_s = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma x^2 \ \Sigma y^2}} = .885$

   $\text{Prob}\ (r_s \geq .885 | H_0) < p = .01$ For $N = 6$

5. Conclusion

Since Prob $< \alpha = .1$ we can reject H_0 and accept the hypothesis that performance and copilot gunner time in service are associated positively.

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