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A CONCEPTUAL MODEL OF THE PERFORMANCE OF THE UNITED STATES AIR FORCE FLIGHT TRAINING PROGRAM

John P. McGarrity, Capt, USAF
Larry T. Looper
R. Scott Curtis, Capt, USAF

MANPOWER AND PERSONNEL DIVISION
Brooks Air Force Base, Texas 78235-5601

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LABORATORY

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235-5601

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WILLIAM E. ALLEY, Technical Director
Manpower and Personnel Division

MICHAEL W. BIRDLEBOUGH, Colonel, USAF
Chief, Manpower and Personnel Division

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John P. McGarrity
Larry T. Looper
R. Scott Curtis

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Manpower and Personnel Division
Air Force Human Resources Laboratory
Brooks Air Force Base, Texas 78235-5601

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The purpose of this paper is to present a conceptual approach for measuring the program performance of the Air Force Flight Training Program (FTP). The paper is divided into five sections: The introduction provides the background information on four different FTP options addressed by Stoker, Hunter, Kantor, Quebe, and Siem (1987) and establishes the general construction of the program performance model; the second section addresses the effectiveness of the FTP in relation to graduation rates; the efficiency section develops the cost for each of the FTP options; the fourth section, on performance, presents a way to compare the efficiency and the effectiveness of each program; and the concluding section provides a summary of the benefits to be derived from use of one of the four options.

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John P. McGarrity, Capt, USAF
Larry T. Looper
R. Scott Curtis, Capt, USAF

MANPOWER AND PERSONNEL DIVISION
Brooks Air Force Base, Texas 78235-5601

Reviewed by

Larry Looper
Chief, Decision Models Function
Manpower and Personnel Division

Submitted for publication by

David E. Brown, Lt Col, USAF
Chief, Force Management Systems Branch
Manpower and Personnel Division

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SUMMARY

This paper develops a strategy for approaching the problem of measuring the performance of a training program. The performance of a program consists of two components, effectiveness and efficiency. These two components can be further divided into the two subcomponents of selection and training. This structure results in four training program measurement variables: training effectiveness, selection effectiveness, training efficiency, and selection efficiency. After collecting measures on each of the program options for these variables, efficiency and effectiveness were related through indifference curve analysis to determine which program would provide the best result. This combined measure, program performance, shows that a 20-hour Flight Screening Program with the Basic Attributes Tests as a screening device and the current Undergraduate Pilot Training program could save the U.S. Air Force over $50 million annually.

PREFACE

The present research was accomplished as a cost comparison of four different Flight Screening Program (FSP) options that were studied in the Air Force Human Resources Laboratory (AFHRL) paper TP-86-59, "Flight Screening Program Effects on Attrition in Undergraduate Pilot Training" by Stoker, Hunter, Kantor, Quebe, and Siem. It is suggested that the reader review the Stoker et al. report before reading this paper as it will greatly aid in the comprehension of this report. Direction for the study was provided by Dr. William Alley of AFHRL's Manpower and Personnel Division. We also thank Mr. Rich Hutchins and Maj Rick Perry of the Air Training Command for their assistance in collecting cost data and Mr. Larry Looper of AFHRL for his review of this report.

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A CONCEPTUAL MODEL OF THE PERFORMANCE OF THE UNITED STATES AIR FORCE FLIGHT TRAINING PROGRAM

I. INTRODUCTION

This paper describes a conceptual model used to measure the efficiency and effectiveness of the Flight Screening Program (FSP) in the production of Air Force pilots. In the design, implementation, and funding of any training program, the goal is to maximize the performance of the program for a given budget. The conceptual model presented in this paper shows that the performance of the Air Force Flight Training Program (FTP), which is composed of the FSP and Undergraduate Pilot Training (UPT), can be increased at a reduced cost.

The FTP conceptual model was composed of two primary components: efficiency and effectiveness. Each of these components was further subdivided into two subcomponents of selection and training, thus creating four variables: training effectiveness, selection effectiveness, training efficiency and selection efficiency. The tree diagram in Figure 1 depicts the FTP conceptual model. The factors in parentheses (e.g., FSP graduation rate) represent measures of each of the variables selected for use. Although the factors serve as measures for their respective variables (as shown in Figure 1), Stoker, Hunter, Kantor, Quebe, and Siem (1987) showed that each of the measures also has a secondary effect on a related variable (as indicated by the dashed lines in Figure 1). For example, though FSP is primarily a screening device for FTP (and thus, a measure of selection effectiveness), it does confer some training benefit that is useful in UPT. Conversely, although UPT is primarily a training program, it also contributes to selection effectiveness in that it eliminates from the FTP those individuals who are not qualified for further flight training.

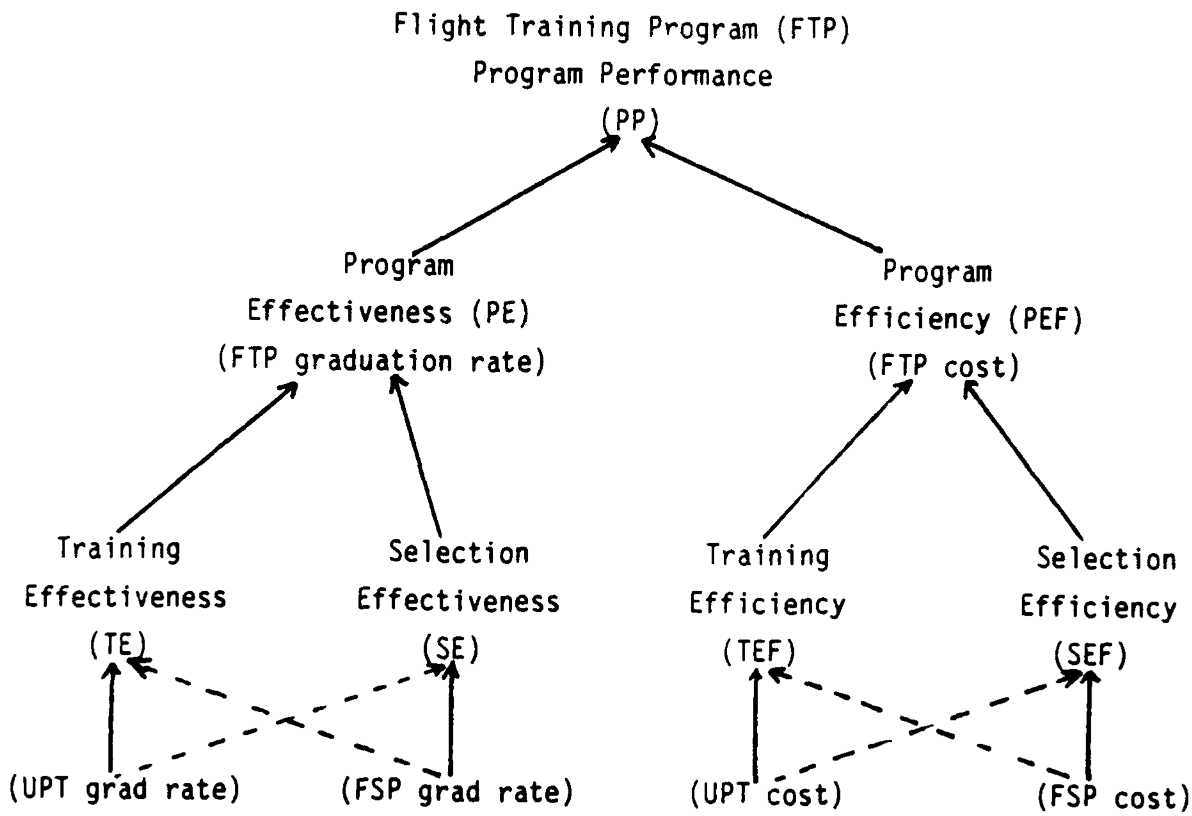

Figure 1. **Conceptual Model of Program Performance of FTP.**

Several assumptions about selection and training were made as the model of program performance was developed. First, it was assumed that both selection and training existed on a continuous scale, which allowed for infinite combinations of selection and training. This assumption affected the various relative values that are presented later. Next, it was very difficult to separate the part of a program that impacted personnel selection and the part that affected training. This difficulty and the lack of direct measures necessitated the use of surrogate measures for each of these components.

The conceptual model of the FTP will be presented in the following four sections. Section II addresses the effectiveness of FTP and focuses on the results of the Stoker et al. (1987) study. It also shows how changes in the amount of hours flown in FSP affected the FTP graduation rate. Section III on efficiency presents a cost analysis of the data from the Stoker et al. report and some possible savings if alternative training recommendations are implemented. Section IV on performance brings the results of the effectiveness and efficiency sections together through the use of indifference curves. The concluding section outlines recommendations to improve FTP.

II. EFFECTIVENESS

The two variables of program effectiveness (PE) used in the model were selection effectiveness (SE) and training effectiveness (TE). SE was defined as the ability of the program to accurately select those candidates who have the aptitude to graduate from UPT, and used FSP graduation rate as the measure. TE was defined as the ability of the program to prepare and train individuals mentally and physically so that they can be successful UPT graduates (Stoker et al., 1987); the measure for TE was UPT graduation rate.

The Stoker et al. study related four different FSP options to differing FTP graduation rates. In the current study, results from Stoker et al. were used to construct four different groups of FTP students, with each group experiencing a different FSP. Even though the results from Stoker et al. form the basis of this study, they are used here only as a demonstration of the methodology. The four hypothesized groups used in this study are described below.

Group 1. This group would not experience FSP. Instead, they would directly enter UPT with no prior screening or training.

Group 2. The students from this group would enter the normal 14-hour FSP and then be selected for UPT or drop out of the program.

Group 3. These students would enter a 20-hour FSP, with screening taking place at the same time as that experienced by Group 2. The 6 additional hours of FSP would provide more training for the students.

Group 4. This group was not directly discussed in the Stoker et al. report. However, by introducing the Basic Attributes Tests (BAT)--which allow for screening to take place at an earlier time with an equivalent level of confidence--into the 20-hour program, the same level of screening and training would be maintained since there are no changes in the flying program of FSP.

Table 1 presents a summary of the four groups, their relationship (if any) to Stoker et al., the number of hours flown in FSP by each group, and their respective levels of SE (FSP graduation rate), TE (UPT graduation rate), and PE (FTP graduation rate).

Table 1. **Results of Differing FSP Options**

McGarrity-Curtis Group	Stoker et al. Group	FSP Option (Hours)	SE (%)	TE (%)	PE (%)
1	1	none	100	56	56
2	3	14	77	74	57
3	2	20	77	88	68
4	-	20 (+ BAT)	77	88	68

Although Groups 1, 2 and 3 all differed from each other by the amount of flying time that they were allowed, Group 4 differed from the other groups because of the inclusion of psychomotor test scores from the Basic Attributes Tests (BAT). These tests, which aided in the selection decision of students for UPT, measured the eye-hand coordination skills of the individual. The Stoker et al. report showed that selection for UPT could be made at an earlier point in FSP (as early as the eighth FSP flying hour) using flight performance data and results from BAT testing and be as statistically accurate as a selection decision made at any later time without BAT results (p. 10). The earlier selection decision did not affect SE, PE or TE values in the comparisons between Group 3 and Group 4; however, it did have an impact on the efficiency of the program as will be discussed later.

The first three groups had differing levels of SE (FSP graduation rate) and TE (UPT graduation rate), which affected the overall PE as measured by the FTP graduation rate. FTP rates were generated by multiplying the UPT (TE) and the FSP (SE) graduation rates together. SE for Group 1 was assumed to be 100% so that consistency in the computations could be maintained. The SE level for Group 1 provides an example of the selection and training overlap mentioned earlier since all selection decisions would be made in UPT and not in FSP. The TE level of the first group was 56% due to the fact that the UPT graduation rate for this group was 56%.

The PE value (FTP graduation rate) for Group 2 increased by a single percentage point over that for Group 1, due to an increase in the amount of TE from 56% to 74%. Groups 3 and 4 experienced an increased level of PE over that for Group 2. This higher level (68% vs 57%) was a result of the increase in TE. The increase in PE was 11 percentage points higher than the PE for Group 2 and 12 percentage points higher than that for Group 1.

Figure 2 shows how increases in FSP flying hours affect FTP graduation rate. The increasing rate of the slope of the curve suggests that at some point beyond the 20th FSP hour, a more effective program could be established perhaps because more skills could be taught in FSP and applied in UPT than is currently the case. The lengthening of FSP increases the amount of training that would go on in FSP, which increases the overlap between the two measures, SE and TE.

III. EFFICIENCY

To determine the efficiency component of Program Performance, a costing methodology was developed to compute the cost to graduate pilots from UPT. By specifying that the number of UPT graduates was the same for all of the FSP options, it was possible to standardize the results and provide accurate cost comparisons. As in effectiveness, the efficiency measures were split into variables of selection and training. Selection efficiency (SEF) was measured by the cost of FSP, and training efficiency (TEF) was measured by the cost of UPT.

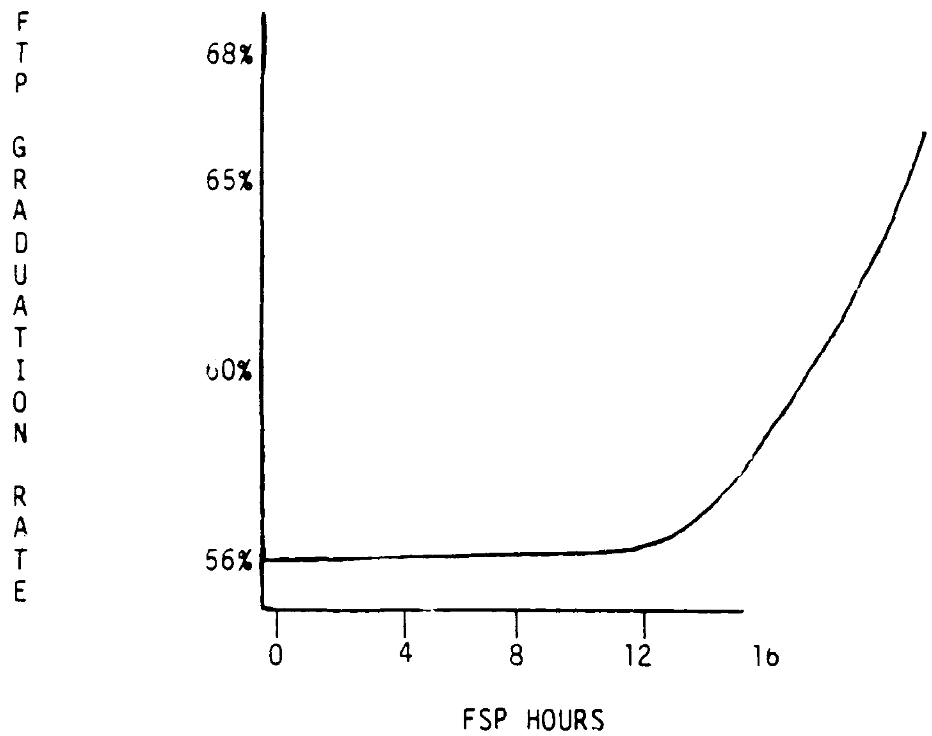

Figure 2 **FSP Hours vs FTP Graduation Rate.**

As an example of the cost impact, it was assumed that each year approximately 2,000 UPT graduates are required by the Air Force. Of these, 1,100 will have FSP as their first introduction to flying. (The remaining 900 are not required to attend FSP because they have their private pilot license or are Air Force Academy graduates and have already gone through a program similar to FSP.) Table 2 shows the various rates and costs for the differing groups and how these rates affect the number of students required to enter FTP in order to generate 1,100 graduates.

The values in columns 1, 4, 6, and 7 of Table 2 are Fiscal Year 1985 data from Air Training Command (ATC). The UPT graduation rate in column 2 came from the Stoker et al. study. Column 3 was calculated by dividing column 1 by column 2. Dividing column 3 by column 4 gave the required FSP entrants in column 5. Column 8 was calculated by multiplying columns 5 and 6 together except for Group 4. (A discussion of the calculations for Group 4's FSP cost is in the next paragraph.) The UPT cost in column 9 was calculated by multiplying columns 3 and 7 together. The total cost in column 10 was reached by adding columns 8 and 9. Column 11 was calculated by finding the difference between Group 2's cost and the cost of all the other groups.

In that Group 2's FTP is currently being used by ATC, the cost of Group 2's option forms the basis from which the other groups are measured. For example, to compare Group 2 (the existing program) and Group 4 one would subtract $283.4 million (Group 4's cost) from $334.6 million (Group 2's cost), yielding $51.2 million, the last entry in column 11.

Table 2. FSP and UPT Costs and Rates

Group	1 UPT Grads	2 Stoker et al. UPT grad Rate	3 Required UPT entrants (1/2)[a]	4 FSP grad rate	5 Required FSP entrants (3/4)
1	1100	56%	1965	N/A	N/A
2	1100	74%	1487	77%	1932
3	1100	88%	1250	77%	1624
4	1100	88%	1250	77%	1624

Group	6 FSP cost/ entrant	7 UPT cost/ entrant	8 FSP cost (5x6)	9[b] UPT cost (3x7)	10[b] FTP cost (8+ 9)	11[b] Savings over group 2
1	N/A	$218637	N/A	$429.6	$429.6	-$95.0[c]
2	$4914	$218637	$9.5	$325.1	$334.6	$0
3	$7020	$218637	$11.4	$273.3	$284.7	$49.9
4	$2908/4212	$218637	$10.1[d]	$273.3	$283.4	$51.2

[a]Numbers in parentheses represent functions between columns to arrive at new column values (e.g., required number of UPT graduates in column 1 is divided by the UPT graduation rate in column 2 to derive the required number of UPT entrants in column 3).
[b]Costs in columns 8, 9, 10, and 11 are in millions of dollars.
[c]A negative savings represents increased cost.
[d]See text for calculating the FSP cost for Group 4.

There are two points that need to be highlighted from Table 2 concerning the FSP cost estimation for Group 4. First, the BAT cost associated with Group 4 was computed by multiplying the cost to administer the test, $100, times the number in column 6 of Table 2 for Group 4 (Group 4 was the only group that used the BAT tests in the selection of people to go to UPT). Next, the calculation of FSP cost for Group 4 required two values in column 6 of Table 2. The calculation is different from the one shown at the top of the column because the assumption of when attrition occurs was changed in the fourth group from that in the preceding three groups. In the first three groups it was assumed that attrition occurred at the end of the program; for Group 4, attrition was assumed to occur at the end of the eighth hour of FSP. This created two sets of students in Group 4. The first set was composed of the entrants to FSP, and the second set was composed of those FSP students who had been selected to go on to UPT. Therefore, the cost of FSP for Group 4 was calculated by multiplying the number of students in column 5 by the first cost in column 6, then multiplying the number of students in column 3 by the second cost in column 6 and adding these two costs together and entering the result into column 8.

IV. PERFORMANCE

The conceptual model of overall FTP program performance shown in Figure 1 requires that program effectiveness and program efficiency be combined; however, this was not possible because program effectiveness and program efficiency were represented using different metrics. To correct for this difference, two solutions were possible: use of expert opinion or application of a notional representation. Because the model was a conceptual one, notional representation was selected to define overall program performance in terms of effectiveness and efficiency.

To show the relationship between efficiency and effectiveness, the economic tool of indifference curve analysis was selected. An indifference curve is a set of points on a curve which represent various combinations of goods or services of equivalent utility in the sense that each of the combinations or choices would be of equal preference to a decision maker. In other words, the utility of one group of goods is equal to the utility of another group of goods (Hirschleifer, 1984). For example, referring to the indifference curves shown in Figure 3, a decision maker for FTP can be indifferent between a program consisting of a specific level of efficiency and effectiveness (point A) and a different level of efficiency and effectiveness (point B) as long as both points are on the same curve (PP_2).

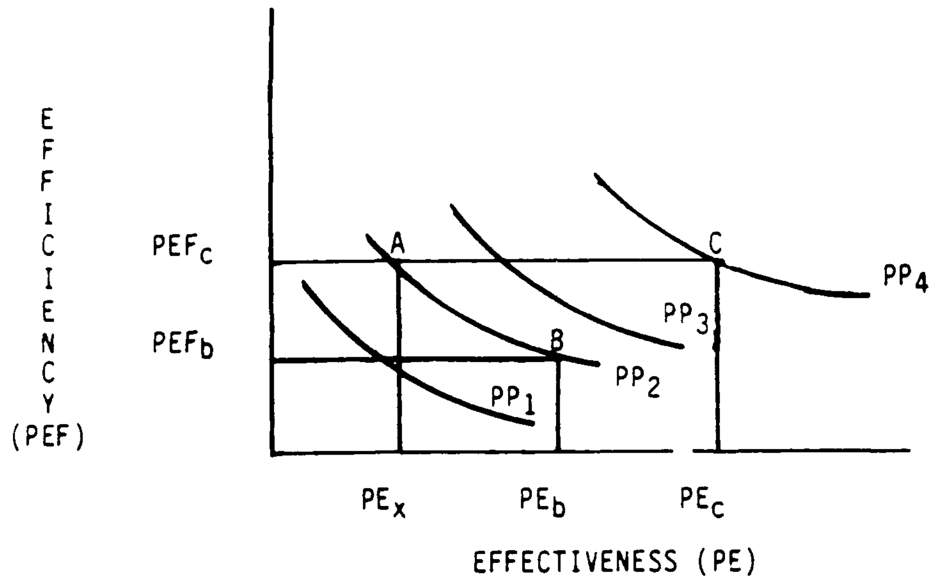

Figure 3. **Effectiveness vs Efficiency (All Groups).**

An improvement in training or selection technologies would result in movement to another curve, one that is farther from the origin. (The farther a curve is from the origin in a positive direction, the greater utility to the decision maker the curve represents.) Therefore, the mixture of effectiveness and efficiency at point C in Figure 3 is preferred over the options represented by points A and B since point C lies on a curve (PP_4) which is farther out from the origin. Using the approach of indifference curve analysis (Hirschleifer, 1984), it is possible to demonstrate that Group 4 in this study had the highest level of overall program performance.

Curve PP_2 in Figure 3 is the indifference curve for all mixes of efficiency and effectiveness having equal utility for Group 2 (the present FTP). Group 2's effectiveness (57% FTP graduation rate) and efficiency (no dollar savings) are plotted as point B on PP_2. If Group 4 had the same overall performance level as Group 2, it would also be represented by PP_2. If this were the case, to generate the higher level of efficiency shown in Table 1 for Group 4 ($51.2 million savings) and remain on PP_2, there would need to be a drop in effectiveness from PE_b to PE_x. However, this did not occur. Instead, there was an increase in PE from PE_b to PE_c (68% graduation rate), which was possible only if Group 4's overall performance actually lay on a PP curve having greater performance or utility, in this case curve PP_4. By using similar logic, it can be seen in Figure 3 that Group 4's program performance not only exceeded that of Group 2, but was greater than those for Groups 1 and 3. By utilizing the FTP structure of Group 4, the Air Force could now employ an FTP which is more effectiva and efficient tnan that currently experienced--without the extensions to the program.

V. CONCLUSIONS AND RECOMMENDATIONS

In summary, a conceptual framework for dealing with the measurement of a program's success was established. A program's performance was shown to be a function of two components: effectiveness and efficiency. The research results suggest that the implementation of a program similar to that for Group 4 (20 hours of FSP flying time, and the use of the BAT) would save the Air Force approximately $51.2 million annually and provide more effective use of program resources. This conclusion is based on a comparison of different program options that included the efficiency and the effectiveness of each in producing graduates from FTP. Indifference curve analysis showed that a change in training and selection procedures--through the use of the BAT and an improved, 20-hour FSP training curriculum--resulted in movement to a new performance curve that represents an an overall higher performance level for all combinations of efficiency and effectiveness. That is, as time spent in FSP increases, FSP becomes less of a selection program and more of a training program. Also, it is more cost effective to teach basic flying skills in FSP than in UPT. In summary, an expanded FSP with the BAT could, at a low cost, substitute for some of the costly selection and training components of UPT.

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