CAHRS / Cornell University
187 Ives Hall
Ithaca, NY 14853-3901 USA
Tel. 607 255-9358
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Keeping Our Best: Econometric Analysis of Retention and Performance at Engineering Solutions

Gary S. Fields

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Keeping Our Best:

Econometric Analysis of Retention and Performance at Engineering Solutions

Gary S. Fields

Cornell University
School of Industrial and Labor Relations
250 Ives Hall
Ithaca, NY 14853-3901
Tel: (607) 255-4561
Fax: (607) 255-4496
e-mail: gsf2@cornell.edu

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http://www.ilr.cornell.edu/cahrs

Abstract

This study analyzes the retention and performance of 100 engineers who started work at "Engineering Solutions" in 1996, of whom 65 were still with the firm in 2002. The retention analysis shows that the firm retained disproportionately the better performers, those with the psychological attributes that make for greater success, those with greater work attachment, and those with fewer dependent-related job issues. The performance analysis shows that the top-rated engineers are primarily those who exhibit favorable psychological characteristics, that a few other characteristics make a small difference to performance, and that the remaining variables make no difference at all.

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"Keeping Our Best": Econometric Analysis of Retention and Performance at Engineering Solutions

I. Introduction

The drive to attract, develop, and retain top talent is of critical importance to organizations (Gubman, 1998; Johnson, 2000; Michaels, Handfield-Jones, and Axelrod, 2001; Tulgan, 2001; but for a dissenting view, see Pfeffer, 2001). Statistical studies of human resource management in organizations are of two major types. Some studies compare organizations, relating a talent metric in each organization such as the retention rate or the performance level of employees to characteristics or practices of the organization or of its workers such as firm size, industry, and human capital practices (Huselid, 1995; Holzer, 1997; Shaw et al., 1998; Guthrie, 2001; William M. Mercer, 2001; DeVaro and Fields, 2002). Other studies focus on a single organization, analyzing the attraction, retention, development, performance, or potential of each individual employee (Medoff and Abraham, 1980, 1981; Caldwell and Spivey, 1983; Kirman, et al., 1989; Lazear, 1992; Baker, Gibbs, and Holmstrom, 1994a, 1994b; Batt, 1999, 2001). This study is of the second type.

In early 2002, a major consulting company, Deloitte and Touche, provided me with data for one of its clients, here called "Engineering Solutions." Using data from the company's Human Resources Information System (HRIS), I studied the career paths of a sample of 100 engineers who had been hired at Engineering Solutions in 1996 and analyzed the drivers of retention and performance as of the beginning of 2002. Summary statistics for these variables are presented in Table 1.

In this paper, I show how statistical and econometric analysis can help the company hire the people that stay the longest and perform the best. Section 2 presents the results of the retention analysis and Section 3 the performance analysis. Major findings and policy recommendations appear in Section 4.

Table 1
Engineering Solutions:
Summary Statistics for Stayers Compared with Leavers

Note: Unless otherwise indicated, variables are for the year 2001 for stayers, as of the year preceding departure for leavers.

variable	*Engineers Still with the Company as of January, 2002 (“Stayers”) n =65*	*Engineers No Longer with the Company (“Leavers”) n =35*	*Percentage of Those With That Characteristic Still With the Company as of January, 2002*
Current Performance			
Substantially exceeds expectations	8%	0%	100%
Exceeds expectations	43%	9%	90%
Meets expectations	43%	31%	78%
Meets only some expectations	3%	51%	10%
Not meeting expectations	3%	17%	25%
Current Potential			
Can move up at least two levels	32%	11%	84%
Can move up one level	32%	11%	83%
At level	26%	34%	59%
Should be moved down at least one level	11%	43%	32%
Degree as of 1996			
Ph.D.	25%	26%	64%
M.S.	31%	31%	65%
Bachelors	45%	43%	66%
Degree as of 2002			
Ph.D.	32%	34%	66%
M.S.	34%	34%	65%
Bachelors	34%	31%	65%
Type of Degree			
Chemical engineer	55%	51%	67%
Mechanical engineer	45%	49%	63%
Mean Age	35.8	35.3	n.a.
Prior Experience			
	58%	51%	68%
No	42%	49%	61%
Gender			
	65%	57%	68%
Female	35%	43%	61%
Ethnicity			
White	43%	43%	65%
Black	15%	17%	63%
Asian/Pacific	28%	17%	75%
Other	14%	23%	69%
Mean Starting Salary	$41,615	$41,857	n.a.
Mean Current Salary	$71,692	n.a.	n.a.
Communicates Effectively			
Role model	32%	3%	95%
Consistently displays	48%	9%	91%
Sometimes displays	18%	63%	35%
Does not display	2%	26%	10%
Adapts to Change			
Role model	34%	0%	100%
Consistently displays	52%	14%	87%
Sometimes displays	9%	54%	24%
Does not display	5%	31%	21%
Thinks Creatively			
Role model	17%	3%	92%
Consistently displays	58%	14%	88%
Sometimes displays	20%	46%	45%
Does not display	5%	37%	19%
Manages Others Effectively			
Role model	45%	3%	97%
Consistently displays	42%	6%	93%
Sometimes displays	9%	49%	26%
Does not display	5%	43%	17%
Mean Number of Jobs Held Since Joining the Firm	3.5	3.4	n.a.
Mean Number of Separation Days Taken Since Joining the Firm	4.1	30.4	n.a
Mean Current Number of Dependents	1.1	1.7	n.a.

II. Retention Analysis

A. Overall Rate of Retention

Engineering Solutions has had considerable success in retaining engineering talent. 65% of the engineers hired in 1996 were still working with the company five years later. The company feels nonetheless that retention of top talent is less than it might be. The aim of this study is to show how the company might do even better in keeping its best.

The dependent variable for the retention analysis is whether the engineer hired into the firm in 1996 was still working there at the end of 2001 or not. These two groups are called “stayers” and “leavers” respectively. Unfortunately, for the leavers, no information is provided on the year that they left the firm.

One further point to mention regarding the retention analysis is that Engineering Solutions rarely dismisses professionals outright. Those who are judged not to be performing up to standard are encouraged to seek new situations. As evidence presented below shows, the company uses its compensation policies effectively to bring about desired departures.

B. Quality of the Engineers Retained

What is the quality of the engineers who have remained? The company's data base contains a five point performance scale giving the year-2001 performance rating for each engineer still with the firm as of January, 2002 and the performance rating as of the time of departure for each engineer who left the company before 2002. Table 2 presents the distributions of performance scores for the two groups of engineers.

Table 2
Engineering Solutions: Breakdown of Performance for Engineers Who Started with the Company in 1996 and For Those Who Were Still with the Company Five Years Later

Performance Category	*All Engineers Hired in 1996 (n =100)*	*Engineers Still with the Firm in January, 2002 (n =65)*
Substantially exceeds expectations	5%	8%
Exceeds expectations	31%	43%
Meets expectations	36%	43%
Meets only some expectations	20%	3%
Not meeting expectations	8%	3%
Total	100%	100%

At the top end of the scale, 51% of the engineers still with the company in 2002 were performing better than expected, as compared with 36% of those that started with Engineering Solutions. At the bottom end of the scale, 28% of the original engineers were rated as meeting only some expectations or not meeting expectations; by 2002, only 6% of those remaining fell into these less than satisfactory categories. We therefore find that the company has succeeded in retaining a particularly large share of the better performers and encouraging the departure of low performers.

The superior performance of the engineers retained compared with those that started with the company is one of several indications that Engineering Solutions is managing its people effectively. Other indications are discussed below.

C. Drivers of Retention: Analysis of Profiles and Logistic Regressions

Turning now to the drivers of retention, we find that some variables have an important effect on retention, other variables are somewhat related to retention, and other variables make absolutely no difference at all to retention.

Six variables have an **important effect on retention** at Engineering Solutions. These are **four psychological variables** – communicates effectively, adapts to change, thinks creatively, and manages others – and **two other variables**: number of non-vacation days of absence and the number of dependents. Specifically, our quantitative analysis shows:

- 93% of those who were “role models” or “consistent” in communicating effectively were still with the company after five years compared with 30% of those who “sometimes” or “do not” communicate effectively.
- 89% of those who were “role models” or “consistent” in thinking creatively were still with the company after five years compared with 30% of those who “sometimes” or “do not” think creatively.
- 92% of those who were “role models” or “consistent” in adapting to change were still with the company after five years compared with 23% of those who “sometimes” or “do not” adapt to change.

- 95% of those who were “role models” or “consistent” in managing others were still with the company after five years compared with 22% of those who “sometimes” or “do not” manage others.

Each day of non-vacation absence during the five years since hiring reduces the retention rate by 1 percentage point. Thus, engineers who take one week a year of non-vacation time off are 25 percentage points less likely to be with Engineering Solutions after five years.

Engineers with more dependents were less likely to stay with the firm for five years. We find that each additional dependent reduces the retention rate by 11 percentage points. Thus, while engineers with no dependents would average a 79% rate of retention, those with three dependents would have only about a 46% rate.

A number of other variables exhibited **very small (and statistically insignificant) correlations** with retention:

- 67% of the chemical engineers, as opposed to 63% of the mechanical engineers, were still with the firm five years later.
- Those with prior experience were somewhat more likely than those without prior experience (68% versus 61%) to stay with the firm.
- Men are somewhat more likely (68%) than women (62%) to stay with the firm.
- Race is something of a factor in retention: Whites stayed at exactly the average rate (65%). Engineers of Asian/Pacific origin stayed at an above-average rate (75%) and blacks at a below-average rate (63%), but owing to the small number of each, the differences are not significant.

Other variables in the company's HRIS – degree level, age at time of hire, starting salary, number of different jobs held in the firm since 1996 - were analyzed and were found to make **absolutely no difference** to the retention rate.

Lastly, one final variable is found to be related significantly to retention, but in a complicated way. “Current salary” is the salary as of 2001 for the stayers and as of the year prior to departure for the leavers. These two groups – stayers and leavers – started in 1996 with essentially the same salaries ($41,615 and $41,857 respectively). The mean current salaries of the two groups were respectively $71,692 for the stayers and $56,142 for the leavers – in other words, a $30,000 increase for the stayers and a $15,000 increase for the leavers. This does **not** necessarily imply, though, that the stayers received larger annual salary increases. If salaries are increased at an approximately constant rate each year, and if engineers leave the company at an approximately constant rate each year, then this pattern of salary increases is consistent with the firm raising the salaries of stayers and leavers at **the same** rate as each other. However, as shown below, among the stayers, the firm differentiates salaries carefully according to performance.

Summing up the preceding profile analysis, we have learned for which variables differences in retention rates are large, for which the differences are small, and for which the differences are nil. What the profile analysis cannot tell, however, is the relative importance of the information contained in these different variables. This question corresponds to the following thought experiment. If the company could learn only one fact about the employee, how much information would be yielded? Which fact would be the best predictor of retention?

To answer this question, I ran a series of bivariate logistic regressions taking retention as the dependent variable and entering each of the explanatory variables one at a time. The results appear in Table 3. From this table, we learn two things. First, of the fourteen variables for which we have data, only six are statistically significant in explaining retention. The other eight variables are therefore negligible factors in the retention of engineers at Engineering Solutions. Second, the importance of the significant variables is far from equal. Each of the psychological variables is about twice as important as the number of non-vacation days, which in turn is more than three times as important as the number of dependents.

These findings have important operational implications for the company, as discussed further in Section 4.

Table 3
Engineering Solutions:
Bivariate Analysis of Factors Contributing to the Retention of Engineers.
(n=100)

Independent Variable	*Percentage Contribution of the Variable in a Bivariate Logistic Regression*
Manages others effectively (+)	44.7% **
Adapts to change (+)	39.2% **
Communicates effectively (+)	37.4% **
Thinks creatively (+)	26.8% **
Number of non-vacation days taken (-)	18.4% **
Number of dependents (-)	5.3% **
Ethnicity (+ for Asian/Pacific)	1.7%
Male/female (+ for male)	0.4%
Prior experience (+)	0.4%
Mechanical/chemical engineer	0.1%
Age	0.1%
Degree level	0.0%
Starting salary	0.0%
Number of jobs held in the company	0.0%
Total	n.a.

Notes to Table 3:
Variables marked by a + raise retention. Variables marked by a – lower retention.
The percentage contributions are the pseudo-R^2's obtained from bivariate logits of stay/leave on the independent variable in question. Variables statistically significant at the .01 level are marked by **.
No other variables are found to be statistically significant in this analysis.

D. Drivers of Retention: Regression and Decomposition Analysis

One of the limitations of the bivariate methods used thus far is that a variable that may be significantly correlated with retention may have no **independent** effect once other factors are taken into account. To test for independent effects, a multivariate regression was run in which retention was expressed as a function of all of the preceding variables simultaneously. The results are given in Table 4.

Table 4
Engineering Solutions: Explaining Retention Using Regression Analysis
(Standard Errors in Parentheses)
(n=100)

Effective Communication	0.063
	(0.052)
Adapts to Change	0.101**
	(0.045)
Creative Thinking	0.043
	(0.045)
Manages Others Effectively	0.175***
	(0.046)
Separation Days	-0.005***
	(0.001)
Number of Dependents	-0.088***
	(0.028)
Asian	-0.054
	(0.077)
Black	-0.041
	(0.086)
Male	-0.011
	(0.075)
Prior Experience	0.076
	(0.074)
Chemical Engineer	0.088
	(0.074)
Masters Degree in 1996	0.086
	(0.073)
Ph.D. in 1996	0.061
	(0.078)
Starting Salary	0.0000002
	(0.00000004)
Number of Jobs Held	-0.033
	(0.024)
Age	-0.001
	(0.005)
Constant	-0.160
	(0.282)
R-squared	0.71

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5
Engineering Solutions: Explaining Retention Using Logistic Regression
(Standard Errors in Parentheses)
(n=100)

Effective Communication	0.425
	(1.136)
Adapts to Change	1.813*
	(1.075)
Creative Thinking	0.399
	(1.045)
Manages Others Effectively	2.536**
	(1.293)
Separation Days	-0.087**
	(0.039)
Number of Dependents	-2.107**
	(0.903)
Asian	2.339
	(2.409)
Black	0.941
	(2.029)
White	2.496
	(1.885)
Male	1.694
	(2.312)
Prior Experience	2.076
	(1.931)
Chemical	3.128
	(2.997)
M.S. in 1996	2.652
	(1.868)
Ph.D. in 1996	2.820
	(2.362)
Starting Salary	-0.00005
	(0.00009)
Number of Jobs Held	-0.447
	(0.728)
Age	0.015
	(0.113)
Constant	-11.730*
	(6.808)
Pseudo-R-squared	0.7768

* significant at 10%; ** significant at 5%; *** significant at 1%

When each variable is analyzed in the presence of others, four are statistically significant at the 1% level: adapting to change, managing others, number of non-vacation days taken, and number of dependents. These same patterns hold in a logistic regression (Table 5). All of the variables significant in the linear probability model and the logistic regression were found to be significant in the bivariate analysis as well. Thus, from these multivariate results, we can be confident that each of these four variables has an **independent** effect on retention. However, two other variables that were significant in the bivariate analysis – communicates effectively and thinks creatively – do **not** exhibit statistically significant independent effects in the multivariate analysis. The explanatory variables together explain 71.1% of the variance in retention.

To gauge the information content of these variables, I used a multivariate decomposition model (Fields and Yoo, 2000; Fields, 2001). The model was originally formulated to apportion income inequality to a number of explanatory factors such as education, job experience, and thee. The weights from the decomposition are constructed to sum to the total percentage of variance explained, R^2. These weights, derived axiomatically, are given by the following formula:

$$s_j = \frac{a_j * \sigma(X_j) * cor[X_j, Y]}{\sigma(Y)} \quad (1)$$

where s_j is the share of variation in the dependent variable attributed to the j’th explanatory variable, a_j is that variable’s regression coefficient, $\sigma(X_j)$ is the standard deviation of the j’th explanatory variable, $cor[X_j, Y]$ is the correlation between the j’th explanatory variable and the dependent variable Y, and $\sigma(Y)$ is the standard deviation of the dependent variable. The normalized weights p_j are obtained by dividing each s_j by R^2, so that each weight is expressed as a fraction of the total percentage of variance explained and the weights sum to 100%:

$$p_j \equiv \frac{s_j(\ln Y)}{R^2(\ln Y)} \qquad (2)$$

Applying this decomposition procedure to the retention of engineers at Engineering Solutions here (and to the performance of engineers below), the relative contributions of each variable to explaining retention (or performance), with the direction of the effect appearing in parentheses for the larger ones, are displayed in Table 6.

Table 6
Engineering Solutions: Multivariate Decomposition of the Factors Contributing to the Retention of Engineers.
(n=100)

Independent Variable	***Percentage Contribution of the Variable in a Multivariate Decomposition***
Psychological variables: communicates effectively, adapts to change, thinks creatively, manages others (+)	65.6%
(1) Number of non-vacation days taken (-)	14.1%
(2) Number of dependents (-)	7.6%
Ethnicity (+ for Asian/Pacific)	4.3%
Prior experience (+)	0.9%
Mechanical/chemical engineer (+ for chemical)	0.5%
Age	0.1%
Degree level	0.1%
Starting salary	-0.1%
Male/female	-0.4%
Number of jobs held in the company	-0.5%
Total	100%

Note: The weights here are derived using equations (1) and (2) in the text

Table 6 shows that the psychological variables account for two-thirds of the turnover behavior of engineers, more than all other factors do together. In a distant second place is number of non-vacation days taken, followed by number of dependents, and then ethnicity. Each of the seven remaining variables explains less than 1% of what is explained. The rankings of these variables in the multivariate results are consistent with the bivariate results presented in Table 3 and discussed above in subsection C.

E. Implications for the Company

The information in this retention analysis is of enormous operational significance to Engineering Solutions. Based on these results, they can now conduct their hiring knowing which variables make an important difference to retention **for them**. Some variables – the psychological factors, number of non-vacation days taken, and number of dependents – are of clear importance. Others make little or no difference. These findings tell us which variables the company's retention efforts should focus on and which make so little difference that they can safely be ignored. We return to this point in the conclusion.

III. **Performance Analysis for the Stayers**

A. Index of Current Performance

At Engineering Solutions, each employee receives an annual performance evaluation. The overall evaluation is summarized on a five-point scale: "substantially exceeds expectations," "exceeds expectations," "meets expectations," "meets some expectations," "not meeting expectations." For purposes of this analysis, these five categories are scaled from +2 to –2. These evaluations of current performance are for the 2001 year for the stayers; they are for the year preceding the departure for the leavers.

Table 2 above showed that the company has retained a disproportionate number of its high performers. This is good news for Engineering Solutions. Some companies hire high performers and keep them for as long as possible, knowing that the best performers will soon leave for better opportunities elsewhere. Companies that do this get outstanding performance from these high-performing employees for the time they are with the firm; the benefits of high performance, even for a relatively short time, are thought to outweigh the subsequent hiring and training costs incurred when the high performers leave. At Engineering Solutions, though, there is no such tradeoff: the better-performing engineers are staying **longer**.

What did the company do to keep its best? As we shall show, they have been successful at identifying and retaining top talent. The following statistical analysis indicates what this successful package was.

B. The Drivers of Performance: Variables Known at the Time of Hire

To analyze how the variables known at the time of hire and included in the HRIS affect performance, I ran four tests. First, I calculated Pearson correlation coefficients (Table 7). The only variables found to be significantly related to performance were type of engineer and degree level. Chemical engineers and Ph.D's were found to perform significantly worse than engineers with bachelor's degrees only. All other variables known at the time of hire exhibited very small correlations with performance and were statistically insignificant.

Table 7
Engineering Solutions: For the Stayers, Correlations Between Performance and Variables Known at the Time of Hire
(n=65)

Independent Variable	*Correlation Coefficient*
Ph.D. in 1996	-0.2178*
M.S. in 1996	0.0064
Chemical Engineer	-0.2197*
Age	0.0786
Asian	0.1338
Black	0.0041
White	0.0688
Male	0.00927
Prior Experience	0.0888
Starting Salary	0.0825

Second, to assess the magnitude of the differences, I ran a number of regressions with the five-point performance scale as the dependent variable and each of the explanatory variables or explanatory variable categories entered individually as independent variables.[1] Chemical engineers and Ph.D's both performed about 0.4 performance points below average.

Third, to test whether the variables found to be important in the bivariate regressions remain important in the presence of other variables, I ran a multiple regression of performance on the variables that were known in 1996; the results are in Table 8. In the multiple regressions as in the simple ones, Ph.D's perform significantly worse than engineers with bachelor's degrees only. Now, though, controlling for other factors, 1) the poorer performance of chemical engineers is no longer statistically significant but 2) Asians' higher performance becomes statistically significant. Other variables remain statistically insignificant.

[1] I also ran ordered logits, which produced qualitatively identical results to the regression results reported in the text.

Table 8
Engineering Solutions: Explaining Performance Among the Stayers Using Variables Known at the Time of Hiring
(Standard Errors in Parentheses)
(n=65)

Independent Variable	*Regression Coefficent*
Ph.D. in 1996	-0.723**
	(0.285)
M.S. in 1996	-0.120
	(0.262)
Chemical Engineer	-0.333
	(0.244)
Age	0.012
	(0.016)
Asian	0.576**
	(0.258)
Black	0.265
	(0.301)
Male	0.015
	(0.244)
Prior Experience	0.086
	(0.271)
Starting Salary	0.000005
	(0.00001)
Constant	0.006
	(0.822)
R-squared	0.19

* significant at 10%; ** significant at 5%; *** significant at 1%

Finally, I decomposed the regression results using the method described above and derived weights for the variables known at the time of hiring. The results are given in Table 9. These results show that of the variables that were known at the time of hiring, the only one that is at all large in explaining performance is ethnicity.

Table 9
Engineering Solutions: Decomposition Analysis of Determinants of Performance Using Variables Known at the Time of Hiring
(n=65)

Independent Variable	**Percentage Contribution of the Variable in a Multivariate Decomposition**
Ethnicity	65.6%
Degree level	12.9%
Prior Experience	10.3%
Gender	6.0%
Starting Salary	3.4%
Age	1.7%
Number of Dependents	0.9%
Degree type	0.0%
Total	100%

Note: The weights here are derived using equations (1) and (2) in the text.

Taken together, the multiple regressions and decompositions tell a consistent story, showing that of the variables that were known at the time of hiring, the major variable explaining performance is ethnicity.

C. <u>The Drivers of Performance: Variables About Which Information Has Been Acquired Since the Time of Hire</u>

The previous subsection B analyzed the effects on performance of variables that were known at the time of hire. This subsection analyzes the effects on performance of variables that became known since the time of hire.

The first calculations are for correlation coefficients and simple regressions. The psychological variables, about which information is acquired once the employee has been on the job, are found to be significantly correlated with performance. All are found to raise performance. All of the psychological variables raise performance. These effects range from 0.5 performance points for a one point improvement in managing others, adapting to change, and communicating effectively to 0.7 performance points for a one point improvement in thinking creatively.[2] Each psychological variable is significantly related to performance with a correlation coefficient of 0.5 or higher. On the other hand, three other variables that are learned later – number of dependents as of 2002, number of non-vacation separation days taken through the end of 2001, and total number of jobs held in the company – also exhibit positive but statistically insignificant associations with performance.[3]

To test whether the psychological variables remained important once the effects of the other variables were taken into account, I ran a multiple regression and obtained the results shown in Table 10.

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[2] Here too, the regression results are confirmed by ordered logits.

[3] It is not known whether the company knew the number of dependents as of the date of hire in 1996. In any event, this information is not contained in the current computerized records.

Table 10
Engineering Solutions: Regressions Explaining Performance Using Variables Learned After the Time of Hiring
(Standard Errors in Parentheses)
(n=65)

Independent Variable	
Number of Dependents	0.037
	(0.073)
Separation Days	0.003
	(0.005)
Effective Communication	0.220*
	(0.121)
Adapts to Change	0.255**
	(0.100)
Creative Thinking	0.465***
	(0.108)
Manages Others Effectively	0.144
	(0.109)
Number of Jobs Held	0.019
	(0.043)
Constant	-2.921***
	(0.383)
R-squared	0.61

* significant at 10%; ** significant at 5%; *** significant at 1%

We see that the psychological variables are the only ones that remain important in the presence of other variables, and furthermore their effects are reduced in the presence of each other compared to the simple regressions. Still, the effects are quite large: these results predict that an engineer who rates one point higher on the five-point scale for each of the psychological variables would perform a full point better – for example, moving from "meets expectations" to "exceeds expectations." This would be a very large and significant improvement in performance, demonstrating the importance of knowing the drivers of performance and managing towards them.

D. The Drivers of Performance: Putting the Two Sets of Variables Together

The preceding performance analysis showed that ethnicity was the most important variable that was known at the time of hiring and the psychological variables were the only important ones that were learned later. Are both sets of variables important in the presence of one another? I ran a multiple regression with all of the variables used to explain performance as well as an accompanying decomposition analysis and obtained the results shown in Tables 11 and 12.

Table 11
Engineering Solutions: Regressions Explaining Performance Using All Variables
(Standard Errors in Parentheses)
(n=65)

Independent Variable	*Regression Coefficient*
Ph.D.	0.029
	(0.225)
M.S.	-0.026
	(0.222)
Chemical Engineer	0.329*
	(0.192)
Age	-0.000
	(0.012)
Asian	0.343*
	(0.182)
Black	0.076
	(0.229)
Male	-0.153
	(0.179)
Prior Experience	0.225
	(0.208)
Starting Salary	0.0000006
	(0.000009)
Number of Dependents	0.034
	(0.081)
Separation Days	0.002
	(0.005)
Effective Communication	0.216*
	(0.127)
Adapts to Change	0.259**
	(0.106)
Creative Thinking	0.478***
	(0.114)
Manages Others Effectively	0.183
	(0.118)
Number of Jobs Held	0.104
	(0.076)
Constant	-3.712***
	(0.727)
R-squared	0.67

* significant at 10%; ** significant at 5%; *** significant at 1%

The regression results show:

- Other things equal, engineers who are judged by their supervisors to be creative thinkers, more adaptable to change, more effective communicators, and better managers of others are significantly better performers. The magnitudes of these effects are 0.5 performance points, 0.3 performance points, 0.2 performance points, and 0.2 performance points respectively.
- Other things equal, chemical engineers are significantly better performers than mechanical engineers, by about 0.3 performance points.
- Other things equal, engineers of Asian/Pacific origin perform about 0.3 performance points better.

The decomposition analysis in Table 12 confirms that the importance of the psychological variables. They explain almost everything that is explained. Of very minor importance are ethnicity and number of jobs held in the company.

Table 12
Engineering Solutions: Decomposition Analysis of the Factors Contributing to the Performance of Engineers

Independent Variable	**Percentage Contribution of the Variable in a Multivariate Decomposition**
Psychological variables: communicates effectively, adapts to change, thinks creatively, manages others	93.3%
Ethnicity	3.6%
Number of jobs held in the company	3.4%
Prior experience	1.2%
Starting salary	0.2%
Age	0.1%
Degree level	-0.1%
Number of dependents	-0.2%
Mechanical/chemical engineer	-0.5%
Gender	-0.6%
Number of non-vacation days taken	-0.7%
Total	100%

Note: The weights here are derived using equations (1) and (2) in the text.

E. Can the Psychological Variables Be Predicted?

Given the importance of the psychological variables for performance, it would be interesting to know if these variables can be predicted from readily-observed traits of individuals. To investigate this, I ran regressions (reported in Table 13) and ordered logits (not reported) with each of the psychological variables as the dependent variable and education, type of degree, age, ethnicity, gender, and prior experience as explanatory variables. The adjusted R-squareds are very low, indicating that these explanatory variables taken together do not do well in predicting the psychological variables. However, among these 65 stayers, two variables **do** predict psychological outcomes: chemical engineers and Ph.D.'s are found to do worse on the psychological measures, often significantly so. But because the chemical engineers exhibit significantly better job performance ceteris paribus and the Ph.D.'s perform no worse (cf. Table 6), Engineering Solutions should **not** change its hiring practices with respect to these two groups because of their psychological characteristics.

Table 13
Engineering Solutions: Predicting the Psychological Variables
(Standard Errors in Parentheses)
(n=65)

	1. Dependent Variable			
Independent Variable	**Effective Communication**	**Adapts to Change**	**Creative Thinking**	**Manages Others Effectively**
	(1)	**(2)**	**(3)**	**(4)**
Ph.D.	-0.348	-0.485*	-0.610**	-0.175
	(0.275)	(0.285)	(0.254)	(0.285)
M.S.	-0.187	-0.261	-0.091	0.156
	(0.276)	(0.286)	(0.254)	(0.286)
Chemical Engineer	-0.430*	-0.262	-0.490**	-0.519**
	(0.226)	(0.235)	(0.209)	(0.235)
Age	-0.002	0.004	0.021	0.019
	(0.015)	(0.016)	(0.014)	(0.016)
Asian	0.014	0.214	0.254	0.227
	(0.234)	(0.243)	(0.216)	(0.243)
Black	0.023	0.081	0.257	0.437
	(0.306)	(0.317)	(0.282)	(0.317)
Male	0.060	0.088	0.052	0.356
	(0.232)	(0.240)	(0.214)	(0.240)
Prior Experience	0.133	-0.283	-0.066	-0.249
	(0.275)	(0.285)	(0.253)	(0.285)
Constant	3.475***	3.443***	2.512***	2.667***
	(0.628)	(0.650)	(0.578)	(0.650)
Adjusted R-squared	0.016	0.005	0.135	0.100

*significant at 10%; ** significant at 5%; *** significant at 1%

F. Compensation and Performance

As reported above, Engineering Solutions has succeeded in retaining a disproportionate number of its high performers. Further analysis suggests that the firm's compensation policies are an important factor in achieving this happy outcome. For the stayers, I ran a regression of current salary on performance and found that each performance point (on a five-point scale) is associated with more than a $10,000 increase in salary:

$$\text{CURRSAL} = 66438 + \underset{(1728)}{10672}\ \text{PERF},\ R^2 = 0.3770.$$

Viewed differently, the mean salary as of the end of 2001 for the different performance categories was $96,000 for the engineers rated as substantially exceeding expectations, $75,179 for those exceeding expectations, $66,071 for those meeting expectations, and $53,750 for those meeting only some expectations or not meeting expectations. This is another way of seeing that the firm offers widely disparate salaries to its engineers depending on how well or poorly they are performing.[4] Engineering Solutions appears to be wielding the salary weapon effectively in attempting to keep its best.

G. Summary of the Performance Analysis

The results of this section show that for purposes of explaining performance, one group of variables explains just about everything (the psychological variables), while other variables (ethnicity, degree type, and degree level) explain a little and the remaining variables do not matter at all. We have found too that the firm pays substantially higher salaries to engineers judged to be performing better.

We turn now to a more detailed summary of the findings and to policy recommendations suggested by them.

[4] Remember: All these engineers were hired in the same year, so there is no variation in their tenure with the firm.

IV. **Findings and Recommendations**

This study has analyzed the retention and performance of 100 engineers who started work at "Engineering Solutions" in calendar year 1996. Of these, 65 were still at the firm at the start of 2002. Our analysis produced the following major findings.

First, variables that were known to the company at the time of hiring and that are in its Human Resources Information System (HRIS) do a very poor job of explaining retention. Retention is explained better by variables learned **after** the time of hiring.

Second, the company exhibits considerable organizational learning about its people and appears to be managing them accordingly. Variables that the company learned over time about the worker enabled it to retain disproportionately:

- the better performers
- employees with the psychological attributes that make for greater success
- employees who work harder, as represented by fewer non-vacation days taken
- employees with fewer dependent-related job issues

Third, in terms of performance, the top-rated engineers are primarily those who exhibited favorable psychological characteristics. Other characteristics were found to make a small but often insignificant difference to performance, while the remaining variables made no difference at all.

How do these results help Engineering Solutions identify and keep its best? Based on this statistical analysis, I draw six policy conclusions.

First, psychological assessments should be given great weight in initial hiring. These psychological attributes – communicating effectively, adapting to change, thinking creatively, and managing others - have been shown to be the most important ones in explaining both retention and performance. The company should obtain indicators of these capacities **at the time of initial screening** and hire accordingly; they are the ones that matter the most.

Second, the number of non-vacation days taken is a major negative factor in retention. Some high performers may be leaving to join employers who offer more flexible work time arrangements. Engineering Solutions needs to look seriously into what are usually called “family-friendly policies,” but are better thought of as “person-friendly policies,” because they are equally applicable to single individuals. To the extent that employees value flextime for family matters, personal business, and religious holidays, it would make sense for Engineering Solutions to immediately set up “Personal Business Allowances” for their engineers. Such a system would increase retention among loyal, high-performing employees who value a more flexible balance between work and other aspects of their lives than the company's current policy now permits. However, these policies must be considered carefully, because they may generate the wrong selection of applicants.

Third, the number of dependents is a major negative factor in retention. To the extent that the law permits, the company should look carefully at the engineers’ family situations. Engineers with dependents are less likely to have stayed with the firm for the full five years. It may be that spouses and partners have difficulty finding suitable employment opportunities in the community. These difficulties can perhaps be mitigated by hiring a Dual Career Coordinator to help find suitable career opportunities for the spouses and partners of top engineers and other professionals. In considering this, the benefits in terms of retention must be weighed against the cost of the Dual Career Coordinator.

Fourth, like other employers, Engineering Solutions is forced by external pressures to pay higher salaries to engineers with graduate degrees than to those with bachelors degrees only. Our analysis, though, shows that 1) engineers with graduate degrees are no more likely to stay with the company than those with just bachelors degrees and 2) the performance scores of Ph.D.’s are lower than for master’s and bachelor’s degree holders. From the point of view of retention and performance, therefore, the hiring of Ph.D. degree holders should be discontinued unless justified on some other basis (such as the need to have a Ph.D. in order to be able to perform certain kinds of engineering tasks to a high professional standard).

Fifth, it would be helpful to conduct a study of the effect of type of university attended on retention and performance. Information on the school attended was not one of the variables provided for this analysis. If this information were available, we could answer questions like the following. Do the graduates of Ivy League universities and other select institutions perform better? Are they more likely to stay with the company longer? Do more of them possess or develop the kinds of psychological characteristics that have been shown in this study to generate top performance? Information on these questions could help Engineering Solutions target its recruitment efforts more effectively in its efforts to "attract and retain the best."

Finally, many of the variables that might have been thought to matter to retention and performance – educational level, type of degree, ethnicity, gender, prior experience, age, number of jobs held in the company, and starting salary – have been shown either to not matter at all or to have effects that are so small that it does not pay the company to worry about them for purposes of retention and performance. (However, these factors may still be very important to the company for other purposes, such as diversity considerations.) For managers, knowing what does not matter may be as important as knowing what does.

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