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By-Lunneborg, Clifford E.; Lunneborg, Patricia W.

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This study is part of a continuing search for measures of divergent thinking and for better predictors of performance in occupational areas depending on such ways of thinking. Traditional predictors of college performance, ie., high school GPA and tests of verbal and quantitative aptitude have always worked much better estimating success in English, mathematics and biology courses than they have in art, music and architecture. It was found that a more accurate prediction of success for architecture students could be made by using tests designed specifically to tap abilities which architects had judged were related to success in architecture school along with the traditional tests used to predict college performance. Course grades and faculty ratings were predicted for 228 students from Architectural School Aptitude Test (ASAT) scores, ASAT scores complemented by 18 traditional academic predictors, the traditional battery alone, and ASAT scores complemented by 16 biographic and interest items. Results showed the ASAT to be useful as a tool for guiding prospective architecture students. ASAT scores alone, however, predicted long-term criteria poorly but when supplemented with other intellective measures or with biographic data, the best predictions over all architecture criteria were made. (CS)

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Architecture School Performance Predicted from ASAT, Intellective and Nonintellective Measures

Clifford E. Lunneborg and Patricia W. Lunneborg

Course grades and faculty ratings through fourth year architecture study were predicted for 228 students from four sets of variables: Architectural School Aptitude Test (ASAT) scores; ASAT scores complemented by 18 traditional academic predictors; the traditional battery alone; ASAT scores complemented by 16 biographic and interest items. ASAT scores alone predicted long-term criteria poorly but complementing the ASAT with either academic or biographic variables produced the best predictions over all architecture criteria with shrunken validities from .43 to .58. Utility of predictors varied with criteria--faculty ratings were largely determined by traditional intellective measures while design performance was a function of nonintellective and background information, which information appears essential to prediction in areas of divergent thinking.

This study is part of a continuing search for measures of divergent thinking and for better predictors of performance in occupational areas depending on such ways of thinking. The traditional predictors of college performance, i.e., high school GPA and tests of verbal and quantitative aptitude, have always worked much better estimating success in English, mathematics, and biology courses than they have in art, music, and architecture. For this reason, the construction of the Architectural School Aptitude Test or ASAT (1965) centered around the predictive effectiveness of traditional measures versus tests designed specifically to tap abilities which architects had judged were related to success in architecture school.

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The original validity study with the ASAT indicated that it did not outperform high school rank-in-class or GPA, but was a useful addition to high school record in predicting architecture performance (Pitcher, Olsen, & Solomon, 1962). Further, evidence was presented that traditional verbal and mathematics scores in combination with high school record were inferior to the ASAT-high school record combination in predicting first year architecture GPA. Even ignoring high school record the verbal and mathematics tests were not as predictive as the six ASAT subtests (adjusting for shrinkage).

The present study was prompted by two effects of the high rate of attrition among students in the validation study (only 24 percent or 145 students had completed their studies in five years). First, the small sample sizes at the twelve participating schools made the results somewhat inconclusive. Secondly, predictors were consequently judged primarily in terms of first year architecture GPA; long-term criteria such as completion or noncompletion for academic reasons were necessarily slighted. It was felt that additional evidence of validity for the ASAT, traditional and nontraditional (nonintellective) measures was needed over a range of criteria of architecture school success.

Method

Subjects. The total sample consisted of 228 students entering the University of Washington School of Architecture between 1964 and 1966. This group was predominantly male (92%), single (96%), and from Washington State high schools (85%).

Predictors and criteria. The initial pool of predictors consisted of age, sex, and (1) ASAT total and six part scores (interest vocabulary, sensitivity to visual phenomena, science reasoning, intersections, complex space

fitting, and incorporated lines), (2) six cumulative high school GPA's: English, foreign languages, mathematics, natural sciences, social studies, and full-credit electives, (3) ten tests: ACE Psychological Exam (Quantitative), Guilford-Zimmerman Survey, Part I (verbal comprehension), CEEB intermediate mathematics, Washington Pre-College (WPC) tests of English usage, spelling, reading speed, reading comprehension, mechanical reasoning, spatial ability and applied mathematics, and (4) fifty biographic and interest variables derived from admissions applications or from a questionnaire administered in introductory architectural design.

There were seven criteria: first year architecture GPA (5 quarter hours of introductory architecture and 9 hours of drawing), second year architecture GPA (18 hours of architectural design and 6 hours of water color), third year architecture GPA (18 hours of architectural design and 24 hours of technical architecture), fourth year architecture GPA (18 hours of design and 29 hours of technical architecture), architecture design GPA (design beyond second year), cumulative all-university GPA, and the average rating (five-point scale) by three architecture professors of student potential based on personal interviews in the second year of architecture.

Procedure. Intercorrelations among the 75 predictors and seven criteria were the basis for narrowing down the number of variables for four sequential predictor selection analyses: ASAT total and part scores; age, sex, high school GPA's and test scores; ASAT with these 18 traditional predictors; ASAT with sixteen of the original 50 nonintellective measures. In each of the sequential predictor selections (Horst & Smith, 1950) variables were added to the predictor set as long as their contribution to prediction outweighed the expected shrinkage in multiple correlation owing to increased number of

predictors. No limit was placed on the potential number of predictors to be chosen so that as many useful variables would be identified as possible. Because of the fluctuation inherent in multiple correlations from one group to another, especially if groups are small, multiple correlation coefficients reported here have been corrected (R_c), i.e., reduced to reflect the expected between-sample shrinkage owing to sample size and number of predictors.

Results and Discussion

The mean ASAT total score for the entire group was 567 with a standard deviation of 101. The average student entered architecture approximately one year after graduating from high school and 24% were enrolled in some other college prior to entering the University.

Correlations between the forty-one predictors and seven criteria are presented in Table 1. The simple correlation coefficients for ASAT total score with all criteria compared closely to the multiple R_c's when ASAT total and part scores were reweighted to provide the best prediction as may be seen in Table 2. It thus appears that the original weighting devised for the ASAT is broadly applicable. The criteria based on third and fourth year work as well as the design GPA, however, had validities of only .18 and below with ASAT total score. In the prediction of faculty ratings slightly better predictions were obtained by increasing the weight given two of the six parts, interest vocabulary and science reasoning.

As can be seen from Tables 2 and 3 (the latter provides a convenient summary of Table 2), for all criteria except first and second year architecture work, the traditional battery (age, sex, high school GPA's, and ten tests) provided substantially better predictions than ASAT scores. However, ASAT scores complemented either with the traditional battery or with the

Table 1

Validity Coefficients for Variables Entered in Predictor Selection Analyses of Architecture School Performance

(N = 228)

Predictors	Criteria						
	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
ASAT total score	34	38	16	-08	18	27	37
ASAT part I (interest vocabulary)	33	21	02	00	03	22	42
ASAT part II (sensitivity to visual phenomena)	17	28	09	-12	10	20	21
ASAT part III (science reasoning)	23	18	12	07	09	28	31
ASAT part IV (intersections)	26	31	17	-13	24	18	21
ASAT part VI (complex space fitting)	14	23	05	-12	11	11	09
ASAT part VII (incorporated lines)	11	21	11	02	06	08	14
Sex (male)	-07	-06	-10	-09	03	-09	-10
Age	18	-02	-01	09	-07	02	-10
HS English GPA	19	17	31	22	22	32	24
HS mathematics GPA	05	23	33	16	18	37	23
HS foreign language GPA	08	09	31	09	17	20	24

Note:--Decimal points omitted. HS denotes high school; WPC, Washington Pre-College.

(Table continued on next page)

Table 1 (continued)

Predictors	Criteria						
	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
HS social studies GPA	18	22	46	-02	33	40	31
HS natural science GPA	16	30	34	09	22	41	42
HS electives GPA	03	04	02	03	03	04	-02
ACE Psychological Exam (Quant)	-05	16	23	-15	02	11	13
Guilford-Zimmerman Survey, Part I (verbal comprehension)	07	14	-04	-12	-07	15	39
CEEB intermediate mathematics test	07	24	37	-17	19	34	24
WPC English usage test	21	23	17	-10	07	34	42
WPC spelling test	21	04	16	-01	06	10	20
WPC reading speed test	11	12	08	-03	04	12	11
WPC reading comprehension test	13	24	08	-05	06	27	36
WPC mechanical reasoning test	27	15	02	-17	02	17	14
WPC spatial ability test	04	16	20	-08	02	18	13
WPC applied mathematics test	14	24	26	-04	16	27	14
Father's occupational level (Roe)	-24	-21	-08	-17	-03	-16	-11
Father college graduate	10	05	-03	30	00	04	04
Mother employed outside home	-05	-06	-09	-16	-18	01	09
Mother college graduate	05	06	-13	-14	-22	04	02

(Table continued on next page)

Table 1 (continued)

Predictors	Criteria						
	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
First born (including onlies)	-08	02	-11	-03	-08	-05	05
Interval HS to entrance in arch	14	13	-13	03	-19	04	10
Attended HS in state	-15	-18	-07	09	-08	-16	-28
Number of hobbies	10	18	07	04	-02	11	26
HS honor recipient	-02	09	26	05	20	12	20
Part-time job in college	-04	01	22	04	11	12	-15
Architecture HS vocational choice	11	06	21	06	33	03	05
Father's occupation business contact	02	-04	-15	-25	-16	-11	02
Father's occupation technical	-12	13	05	12	-05	08	-08
Number creative people in art and architecture cited	28	16	06	14	03	11	33
Drawing score	24	04	17	16	32	12	22
Service motivation for architecture	04	13	07	-04	14	13	23
N	226	201	147	78	124	228	166

Table 2

Standard Partial Regression Weights for Best Sets of Predictors of Seven Criteria of Architecture School Success

Predictors	Criteria						
ASAT	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
ASAT total score	32(1)	42(1)					
ASAT part I (interest vocab)	14(2)						36(1)
ASAT part II (sensitivity to phen)		09(3)				13(2)	
ASAT part III (science reasoning)		-13(2)				24(1)	15(2)
ASAT part IV (intersections)			17(1)	-13(1)	24(1)		
ASAT part VI (complex space fitting)	-07(3)						
ASAT part VII (incorporated lines)	-06(4)						
R_c	35	38	14	-06	20	29	43
18 traditional predictors							
Sex (male)	-11(5)						
Age							16(3)
HS English GPA				44(1)			
HS mathematics GPA				36(3)			

Note:--Order of selection in parentheses following weights with decimal points omitted. Predictor intercorrelations based on 228 Ss administered ASAT of whom 166 had Washington Pre-College (WPC) scores and high school (HS) grades, and 186 had biographic data. Table includes only predictors selected at least once.

(Table continued on next page)

Table 2 (continued)

Predictors	Criteri: First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
HS social studies	20(2)		47(1)	-46(4)	37(1)	26(2)	
HS natural science GPA		19(1)				17(1)	30(2)
HS electives GPA			-13(5)				-10(4)
Guilford-Zimmerman verbal comp			-33(3)		-20(2)		
CEEB intermediate mathematics			25(2)	-32(2)			
WPC English usage test						13(4)	28(1)
WPC spelling test	12(3)		20(4)				
WPC reading comprehension test		16(2)					15(6)
WPC mechanical reasoning test	36(1)			-17(5)		16(3)	
WPC spatial ability test	-14(4)		11(6)				
WPC applied mathematics test		14(3)			13(3)		-10(5)
R_c	37	33	56	40	33	48	52
ASAT plus 18 traditional predictors							
ASAT total score	34(1)	43(1)					
ASAT part I (interest vocab)	21(6)						24(1)
ASAT part II (sensitivity to phen)							-13(7)
ASAT part III (science reasoning)		-20(3)	19(4)	40(6)			
ASAT part IV (intersections)					30(2)	16(3)	16(4)
ASAT part VII (incorporated lines)	-09(10)						

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Table 2 (continued)

Predictors	Criteria						
	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
Sex (male)	-14(7)						-11(6)
Age	15(2)						
HS English GPA	15(3)			39(1)			
HS mathematics GPA				42(3)			
HS social studies GPA			50(1)	-44(4)	43(1)	23(2)	
HS natural science GPA		21(2)				22(1)	29(2)
HS electives GPA			-12(6)				-11(5)
Guilford-Zimmerman verbal comp	-33(5)		-35(3)	-23(7)	-26(3)		
CEEB intermediate mathematics			24(2)	-41(2)			
WPC English usage test	12(9)					11(4)	17(3)
WPC spelling test			19(5)				
WPC reading comprehension test		08(4)					09(8)
WPC mechanical reasoning test	15(8)			-35(5)			
WPC spatial ability test	-18(4)						
R_c	46	43	58	48	43	48	55

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Table 2 (continued)

Predictors	Criteria						
	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
ASAT plus nonintellective variables							
ASAT total score	34(1)	40(1)					
ASAT part I (interest vocab)							34(1)
ASAT part II (sensitivity to phen)		13(6)				14(5)	
ASAT part III (science reasoning)		-16(5)				22(1)	14(6)
ASAT part IV (intersections)					27(2)		
ASAT part VII (incorporated lines)	-09(6)		17(5)				
Father's occupational level (Roe)	-22(2)	-26(2)				-14(4)	
Father college graduate				45(1)			
Mother employed outside home					-17(3)		12(5)
Mother college graduate				-32(3)	-21(5)		
First born (including onlies)	-11(5)						
Interval HS to entrance in arch	13(8)						
Attended HS in-state	-09(4)	-11(4)		14(5)	-15(9)	-17(2)	-19(2)
HS honor recipient			27(1)		18(4)		16(3)
Part-time job in college			29(3)		16(8)	18(3)	-10(7)
Architecture HS vocational choice	14(7)		26(2)		31(1)		
Father's occupation business contact			-20(4)	-28(2)	-21(6)	-12(6)	
Father's occupation technical		18(3)			-20(7)		

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Table 2 (continued)

Predictors	Criteria: First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
Creative people cited in art, arch	17(3)			15(4)			
Service motivation for architecture		11(7)				09(7)	15(4)
R_c	48	48	44	46	52	38	54

Table 3

Corrected Multiple Correlation Coefficients for Best Sets of Predictors of Seven Criteria of Architecture School Success

(Decimal points omitted)

Predictor set	Criteria						
	First year arch GPA	Second year arch GPA	Third year arch GPA	Fourth year arch GPA	Arch design GPA	All university GPA	Average faculty rating
ASAT total and six part scores	35(4)	38(3)	14(1)	-06(1)	20(1)	29(2)	43(2)
18 traditional predictors	37(5)	33(3)	56(6)	40(5)	33(3)	48(4)	52(6)
ASAT, 18 traditional predictors	46(10)	43(4)	58(6)	48(7)	43(3)	48(4)	55(8)
ASAT, 16 non-intellective variables	48(8)	48(7)	44(5)	46(5)	52(9)	38(7)	54(7)
N	226	201	147	78	124	228	166

Note:--Number of variables in best set follows R_c in parentheses.

biographic and interest variables performed better than the traditional battery alone for all criteria save all-university GPA where prediction from social studies and natural science GPA's and English usage and mechanical knowledge tests could not be improved upon. The ASAT together with the traditional battery provided the best predictions of faculty rating, third, and fourth year grades, while biographic and interest items combined with the ASAT provided the highest multiple correlations with first and second year grades as well as advanced design.

Briefly, the biographic correlates of architecture performance based on the predictor selections involving ASAT and nonintellective variables include the following. Roe's (1956) occupational level of father was oft-selected and indicates that the higher family socio-economic status, the better student performance in architecture. Similarly, for fourth year grades, father's education was the most potent predictor of all. A very good addition to prediction was having attended secondary school out of the state, and perhaps this variable too reflects socio-economic status through capacity to pay nonresident tuition and campus living costs. Performance in architecture was aided by having received honors in high school, by deciding in high school on a vocation in architecture, and curiously, by holding a part-time job in college. Choosing architecture from a social service motivation especially contributed to faculty opinion of student potential. The last nonintellective variable of consequence was that of father's occupation in business contact and selling (Roe, 1956) which adversely affected several criteria.

A first conclusion from examining Table 3 is that given the uneven predictability of criteria within a single school of architecture, probably

any school wishing to use the ASAT must conduct its own validation study, selecting and weighting variables which reflect the emphases in its particular curriculum. The relative importance to success of design courses, technical courses, and courses required in areas outside architecture, such as physics and social science, will determine the kinds of predictors that get selected.

To illustrate this point from the present study, faculty ratings of student potential were best estimated from the interest vocabulary and science reasoning parts of the ASAT, high school natural science GPA, and WPC English usage. Remembering that verbal and mathematics tests were excluded from the final ASAT battery on the grounds that they overlapped with interest vocabulary and science reasoning (Pitcher et al., 1962), faculty ratings would appear solely a function of traditional, intellective predictors. Advanced design course performance, on the other hand, emphasized in its prediction one of the performance subtests of the ASAT, intersections, and a number of biographic and interest variables: early interest in architecture, receipt of honors in high school, father employed in something other than selling or a technical occupation, mother not employed outside the home. All-university grade average, depending in part on nonarchitecture course work required for graduation, was best predicted by the traditional "classic" battery of measures of academic aptitude and achievement.

Although choice of criterion influenced the effectiveness of all predictors including the ASAT and its parts, this study provides additional evidence of the usefulness of the ASAT as a tool for guiding or advising prospective architecture students. It appears, however, that the effectiveness of the ASAT would be considerably reduced were it not supplemented with other intellective measures or with biographic data. A cautious generalization is that where criteria are short-term, augmentation with traditional

predictors works well, but where criteria approach the ultimate in terms of architecture success, nonintellective background and interest variables account for significant variance in addition to the ASAT. For some time all architectural criteria should be considered equally important. At this stage of exploring divergent thinking and its occupational counterparts, it is as critical to know how an individual will fare in his first year of study as it is to know whether he succeeds professionally some years hence.

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