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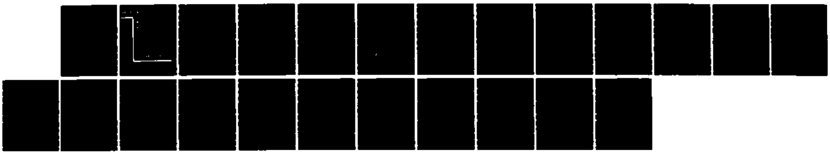

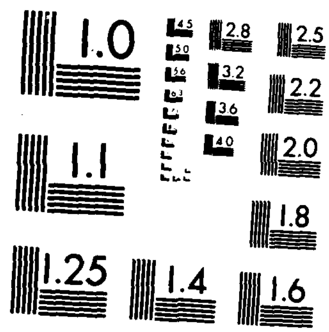

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SKILL/KNOWLEDGE COMMONALITIES IN SELECTED ELECTRONICS SPECIALTIES

Hendrick W. Ruck

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

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The Air Force is interested in consolidating specialties in order to effect more efficient and effective personnel management, personnel utilization, and technical training. The purpose of this research is to develop a methodology for selecting electronics specialties for consolidation. Two different groups of specialties were used. Separate analyses were performed for the 17 Communications-Electronics specialties and the 6 Wire Communications specialties.

The approach was to analyze the skill/knowledge commonality of the two groups of specialties using a variety of statistical techniques. The measures of skill/knowledge utilization were collected from job incumbents on the Electronic Principles Inventory.

Cluster analyses, correlational analyses, and analyses of variance were performed to determine which specialties within each of the two groups had the most similar skill/knowledge requirements. Recommendations for consolidation are presented, as well as potential applications of this technique.

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Reviewed and submitted for publication by

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Chief, Force Utilization Branch

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SUMMARY

The prime objective of this effort was to develop techniques for assessing skill/knowledge commonality among specialties. A secondary objective was to analyze the skill/knowledge commonality among two different groups of electronics specialties. The analysis was designed to develop a method specifically tailored to the question of which specialties could be consolidated to reduce the number of electronics specialties in the Air Force.

This study used a skills inventory approach to measure the skill/knowledge requirements of Air Force jobs. Job incumbents in electronics specialties were asked to indicate, on a skills inventory, whether they used specific electronics skills or knowledge in the performance of their duties. Based on their responses, an electronics principles usage profile was constructed for each specialty. Statistical analyses were performed on the profiles to produce groupings of specialties based on their commonality of skill/knowledge usage.

Statistical techniques included the clustering of specialty profiles based on the absolute value of the differences among specialties, correlational analyses, and analyses of "mean percent using" among specialties. Suggestions regarding consolidations of the 17 Communications-Electronics specialties and the 6 Wire Communications specialties are provided in the report. Two of the Communications-Electronics specialties had such low requirements for electronics skills or knowledge that they were identified as poor candidates for consolidation. Less opportunity for consolidation was found among the Wire Communications specialties than among the Communications-Electronics specialties.

This research developed a technique for quantifying skills/knowledge overlap among electronics specialties. Other techniques may be used when making occupational restructuring decisions. Such techniques also have promising potential in other areas and should be incorporated in future research and development in occupational structures, skills-knowledge inventories, and occupational transferability.

The results of these analyses yielded similar but not identical implications for Air Force specialty consolidation. More work would be required to distinguish which of the options are to be preferred. Present conclusions are based on a judgmental synthesis of the two analyses.

PREFACE

This work was conducted for the Headquarters, Air Force Director of Maintenance and Supply under a special work unit (USAS1605). Results of the effort have been communicated through special-purpose briefings.

The author wishes to express his appreciation to Dr. Raymond E. Christal and Dr. Joe H. Ward, Jr. for their assistance in the design of this effort. The author also wishes to thank Mr. Johnny J. Weissmuller for his invaluable systems analysis and programming efforts in support of the research. In addition, the author wishes to acknowledge the editorial and scientific contributions of Dr. Robert W. Stephenson and Dr. William E. Alley to this manuscript. Finally, the author wishes to especially thank Dr. Walter E. Driskill (USAF Occupational Measurement Center) for collecting the data and cooperating fully in the research.

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ELECTRONICS SPECIALTIES

The Air Force enlisted classification structure is composed of more than 250 distinct job specialties. The requirement exists that specialties be grouped into career fields based on "similarity and transferability of skills and knowledge" (AFR 39-1, 1977, p. 1-1). Although specialties have been grouped into career fields based on similarity of skills requirements, a review of official job descriptions reveals little apparent overlap in the narrative description of the tasks performed by personnel in the different specialties.

If specialties were highly similar in skill and knowledge requirements, opportunities for consolidation would exist that might reduce specialization within the enlisted force. Consolidation of specialties offers the Air Force several advantages. These include (a) increased operational flexibility in the utilization of personnel within field units; (b) facilitation of the assignments process due to larger pools of eligible incumbents and fewer specialties; (c) fewer initial skills courses, resulting in simpler training management; and (d) reduced manning, since specialties would have broader expertise and therefore fewer specialties (and specialists) would be involved in maintaining complex systems. Since consolidation of specialties is such an important issue in the Air Force today, the purpose of this effort is to explore a methodology to quantify similarities in skills and knowledge among specialties.

I. BACKGROUND

One occupational area in particular, electronics, has been quite troublesome because it contains a wide diversity of systems and occupations. Within this occupational area, there are approximately 50 different electronics specialties. "Electronics" specialties may be defined as those which have as an entrance requirement a specified minimum electronics score on the Armed Services Vocational Aptitude Battery (Fruchter & Ree, 1977). Table 1 lists the wide range of specialties in this category. Except for the medical specialties, electronics specialties are the most specialized in the Air Force. The number of airmen employed in electronics varies by specialty from 40 to 9,200, with the average number in a specialty being only 1,150 airmen. For the enlisted force as a whole, the number per specialty ranges from 40 to 25,600 and averages 2,400. One result of the specialization within the electronics community is the creation and maintenance of a large number of technical training courses. In the case of electronics, as is true of other occupational areas, the possibility of identifying commonalities across specialties is enhanced by the existence of a well-defined set of technological "principles" which are covered in a prerequisite course.

In the case of electronics, such principles are not only well defined, they are regarded as requisite knowledge for job proficiency. The possibility that there are principles common to all electronics specialties provides the opportunity for studying the actual overlap in electronics principles utilization among these specialties. Such a study would allow one (1) to investigate the skill and knowledge overlap between selected electronics specialties, with specific concern for pattern and level of usage and (2) to evaluate policy implications relating to (a) the consolidation of Air Force specialties (AFSs) into highly related subsets and (b) the efficient transfer of personnel among specialties to capitalize on previously learned skills. Thus, the purpose of this investigation was to develop and demonstrate a methodology for measuring the skill and knowledge requirements across specialties and examining the commonality of such requirements.

Table 1. Electronics Specialties

Air Force Specialty Code (AFSC)	Title
30250	Weather Equipment Specialist
30251	Airborne Meteorological/Atmospheric Research Equipment (MET/ARE) Repair Specialist
30351	Air Traffic Control Radar Specialist
30352	Aircraft Control and Warning Radar Specialist
30353	Automatic Tracking Radar Specialist
30450	Radio Relay Equipment Specialist
30451	Navigational Aids Equipment Specialist
30454	Ground Radio Communications Specialist
30455	Television Equipment Specialist
30456	Space Communications Systems Equipment Operator/Specialist
30554	Electronic Computer Systems Specialist
30650	Electronic Communications and Cryptographic Equipment Systems Specialist
30651	Electronic-Mechanical Communications and Cryptographic Equipment Systems Specialist
30652	Telecommunications Systems/Equipment Maintenance Specialist
30750	Telecommunications Systems Control Specialist
30850	Space Systems Equipment Specialist
30950A/B	Missile Warning and Space Surveillance Sensor Repair Specialist
31650	Missile Systems Analyst Specialist
31651	Missile Systems Maintenance Specialist
31652	Missile Electronic Equipment Specialist
31653	Instrumentation Mechanic
32150	Bomb-Navigation Systems Mechanic
32151	Defensive Fire Control System Mechanic
32152	Weapon Control Systems Mechanic
32252	Avionics Sensor Systems Specialist
32450	Precision Measuring Equipment Specialist
32550	Automatic Flight Control Systems Specialist
32551	Avionics Instrument Systems Specialist
32650	Avionics Aerospace Ground Equipment Specialist
32653	Integrated Avionics Electronic Warfare Equipment and Component Specialist
32654	Integrated Avionics Computerized Test Station and Component Specialist
32655	Integrated Avionics Manual Test Station and Component Specialist
32656	Integrated Avionics Attack Control Systems Specialist
32657	Integrated Avionics Instrument and Flight Control Systems Specialist
32658	Integrated Avionics Communications, Navigation and Penetration Aids Systems Specialist
32850	Avionics Communications Specialist
32851	Avionics Navigation Systems Specialist
32852	Airborne Warning and Control Radar Specialist
32853	Electronic Warfare Systems Specialist
32854	Avionics Inertial and Radar Navigation Systems Specialist
32855	Airborne Command Post Communications Equipment Specialist
34151	Instrument Trainer Specialist
34152	Defensive System Trainer Specialist
34153	Analog Flight Simulator Specialist

Table 1. (Concluded)

Air Force Specialty Code (AFSC)	Title
34154	Digital Flight Simulator Specialist
34155	Analog Navigation/Tactics Training Devices Specialist
34156	Digital Navigation/Tactics Training Devices Specialist
34157	Missile Trainer Specialist
36251	Telephone Switching Equipment Specialist, Electromechanical
36253	Missile Control Communications Systems Specialist
36254	Telephone Equipment Installation and Repair Specialist
40450	Precision Imagery and Audiovisual Media Maintenance Specialist
40451	Aerospace Photographic Systems Specialist
42350	Aircraft Electrical Systems Specialist
44550	Missile Facilities Specialist
54250	Electrician
54251	Electric Power Line Specialist
91850	Biomedical Equipment Maintenance Specialist

II. APPROACH

Subjects

Journeyman electronics specialists (5-skill level) from each of 23 specialties in two career fields, Communications-Electronics Systems and Wire Communications Systems, were subjects in this study (see Table 2). Only journeymen were included, since earlier studies (Ruck & O'Connor, 1976; Stephenson & O'Connor, 1977) indicated that the journeyman specialists use more electronics principles on the job than do either apprentices or supervisors. The specialties were selected on the basis of a Headquarters, United States Air Force (HQ USAF) request. Seventeen of the specialties were part of the Communications-Electronics Career Field, and the remaining six were in the Wire Communications Career Field.

Instrumentation

The instrument used to gather data about the underlying principles and knowledge required by journeymen in each of the specialties was the Electronic Principles Inventory (EPI). The EPI and its development have been described previously (O'Connor, Ruck, & Driskill, 1978; Ruck, 1977). The EPI was developed at the USAF Occupational Measurement Center for the express purpose of course validation and was not originally intended to be used as a research tool. It contains 1,257 items covering the universe of electronics principles or fundamentals as defined by Air Training Command (ATC) fundamental courses (as of 1974) and by instructors and supervisors of those courses. The items were written such that the job incumbents could indicate whether or not each principle is used on their present job. Lead-in questions and routing instructions were provided to minimize the time required to complete the booklet. For many sets of questions, a "do not remember" response was included as an option after a list of detailed items was offered. This allowed the incumbent a degree of flexibility in response. For example, the respondent could indicate that capacitors are replaced on the present job, but that he or she could not remember which type of capacitor was involved. Table 3 presents sample questions.

Table 2. Specialties Considered for Consolidation

AFSC	Title	Number of journeymen in sample	Percent journeymen in specialty
Communications-Electronics Career Field			
30250	Weather Equipment Specialist	111	20
30251	Airborne MET/ARE Repair Specialist	10	40
30351	Air Traffic Control Radar Specialist	221	26
30352	Aircraft Control and Warning Radar Specialist	309	23
30353	Automatic Tracking Radar Specialist	621	75
30450	Radio Relay Equipment Specialist[a]	1,163	61
30451	Navigational Aids Equipment Specialist	212	27
30454	Ground Radio Communications Specialist	832	23
30455	Television Equipment Specialist	233	53
30456	Space Communications Systems Equipment Operator/Specialist	59	40
30554	Electronic Computer Systems Specialist[b]	350	46
30650	Electronic Communications and Cryptographic Equipment Systems Specialist	769	57
30651	Electronic-Mechanical Communications and Cryptographic Equipment Systems Specialist	116	27
30652	Telecommunications Systems/Equipment Maintenance Specialist	241	19
30750	Telecommunications Systems Control Specialist	498	35
30950A	Missile Det and Warning Radar Specialist[c]	18	30
30950B	Space Surveillance Radar Specialist[c]	42	78
	Career Field Total	5,805	
Wire Communications Career Field			
36150	Cable and Antenna System Installation/ Maintenance Specialist	178	30
36151	Cable Splicing Installation and Maintenance Specialist	164	30
36251	Telephone Switching Equipment Specialist, Electromechanical	106	13
36352	Electronic Switching Systems Specialist[d]	68	30
36253	Missile Control Communications Systems Specialist	61	69
36254	Telephone Equipment Installation and Repair Specialist	108	15
	Career Field Total	685	
	Total	6,490	

[a]Now titled "Wide Band Communications Equipment Specialist."

[b]Now titled "Electronic Computer and Switching Systems Specialist," and merged with 36252.

[c]Now titled "Missile Warning and Space Surveillance Sensor Specialist," and shredouts (A&B) deleted.

[d]Combined with 30554, no longer exists separately.

Table 3. Sample EPI Questions

E1-1 Do you work with coupling devices in your present job? If no, go to item E2-1; if yes, continue.

Do you identify on schematic diagrams and relate to the actual circuitry the components associated with any of the following types of couplings?

E1-2 RC coupling
E1-3 Impedance coupling
E1-4 Transformer coupling
.
.
.

Do you work with any of the following types of coupling circuits?

E1-8 Directly coupled circuits
E1-9 Capacitive-resistive coupled circuits
E1-10 Capacitive-inductive coupled circuits
E1-11 Transformer coupled circuits
E1-12 Don't remember which type of coupling

The EPI is different from the usual task-oriented job inventory in two major respects. First, the EPI asks two simple questions: "What do you do?" and "What electronics knowledge do you use in performing your job?" The usual job-task inventory concentrates on one question: "How much time do you spend on what you do?" A second difference is that the EPI can be administered to anyone who works with electronics. That is, it is general in nature, whereas the usual job inventory is aimed at a single specialty within a career field.

In addition to field tryouts to determine whether airmen could accurately answer the questions on the instrument, extensive content validation studies have been conducted on the EPI (O'Connor et al., 1978). The results of these studies and tryouts, together with the fact that the EPI has been used operationally by ATC to validate courses for more than 5 years, attest to the validity of the instrument.

Survey Methodology

As part of its operational Occupational Analysis Program, the USAF Occupational Measurement Center surveyed airmen in more than 50 specialties using the EPI. Data used in this study were collected between 1976 and 1979. The data were collected to validate or update existing initial skills training for each of the specialties. Surveys were mailed to the Consolidated Base Personnel Offices throughout the Air Force. Survey Control Officers administered EPI booklets to random samples of airmen holding a 5-skill level in their respective specialties. Sample sizes are noted in Table 2.

Analysis

Responses from the EPI were in the form of individual "yes" or "no" indications on each of the 1,257 items. That is, for each individual, a 1,257-item profile of 1 (yes) and 0 (no) responses was derived from the answers to the booklet. A measure was then needed in order to compare the electronics principles used in each specialty across a number of specialties. The measure used to compare specialties was the percentage of journeymen (5-skill level) personnel in each specialty answering "yes" to each item.

The statistical technique used in the analysis was Ward's hierarchical clustering analysis (Ward, 1961). Given _n_ objects, the procedure groups together, on the first iteration, those two objects which are most "similar." In the second iteration, a new group of two objects may be formed, or a third object may be added to the first group. All grouping is based on a measure of similarity. The grouping is repeated until all _n_ objects have been grouped into a single cluster. In this study, specialties were the objects. To derive a similarity index to be input into the grouping algorithm, it was first necessary to compute a difference index. The sum of the absolute value of the differences (in percent using) over the 1,257 items was used as the difference measure. Then, since Ward's technique requires a matrix of similarity indices between all pairs of specialties, the differences were transformed to similarities by (a) converting the differences to percentage of maximum difference (difference index) and (b) subtracting the resulting percentage values from 100%. The raw difference measures were retained to aid in interpretation of the clustering results. The clustering was performed to ensure that all common principles, the degree to which they were used, and the size of each group being analyzed were considered. To provide additional interpretation of the overlap figures, correlations between percent-using variables among specialties that grouped in the cluster analysis were analyzed. In addition, analyses of the number of principles used in each specialty were performed. Separate group analyses were performed for the 17 Communications-Electronics specialties and the 6 Wire Communications specialties.

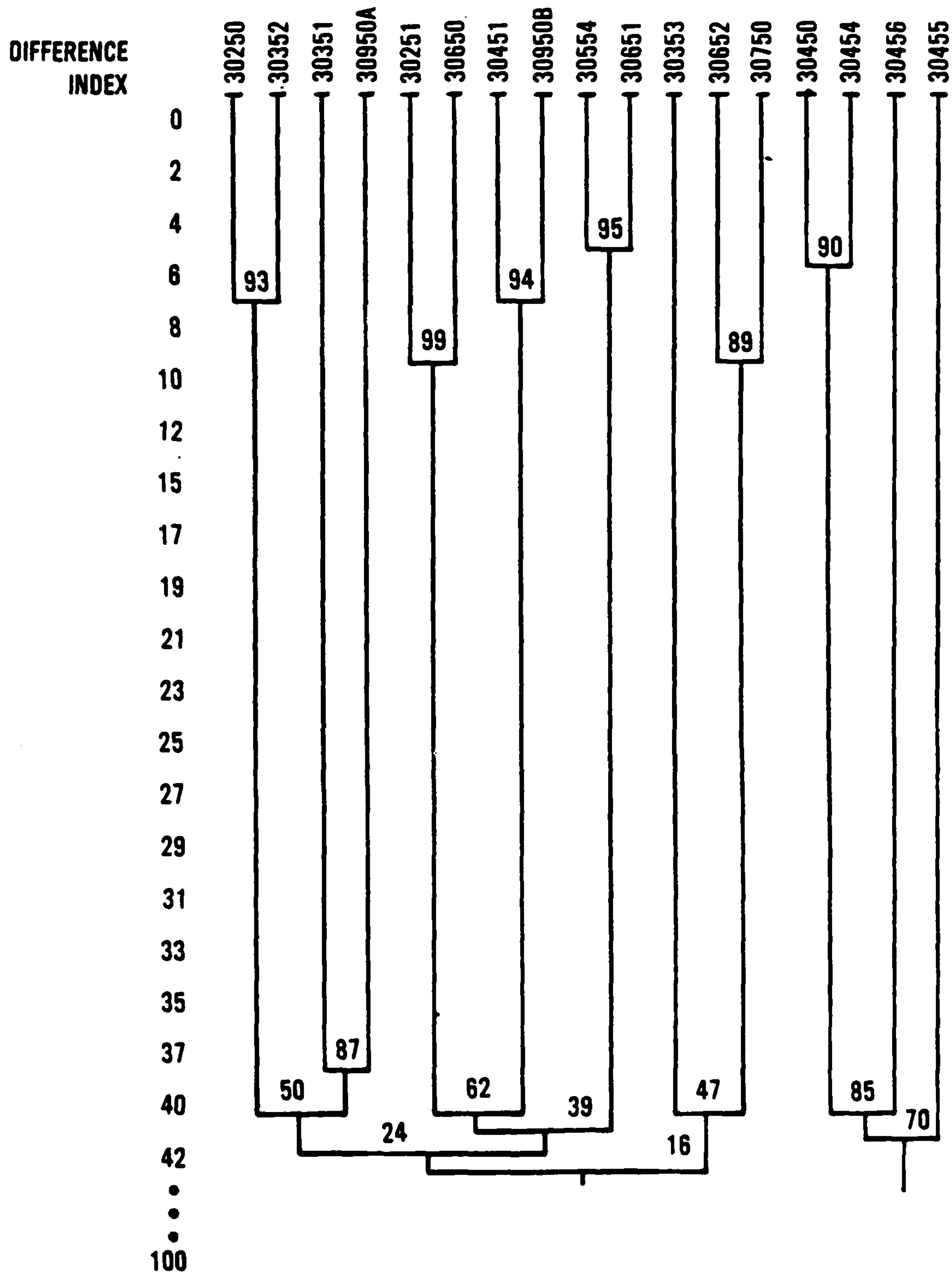
Assumptions

For purposes of this analysis, the EPI was assumed to have included all relevant principles or knowledge required by the Air Force electronics community. Further, each item was assumed to have the same meanings across different specialties. Both assumptions appear justified based on the development and validation procedures used in generating the instrument (Ruck, 1977). An additional assumption was that each principle should be weighted equally in deriving similarity measures.

III. RESULTS

Communications-Electronics Specialties

The results of the hierarchical grouping of Communications-Electronics specialties are shown in Figure 1. The difference index ranges from 0 (all items used by the same percentage of incumbents; i.e., perfect similarity) to 100 (all items used by 100% of one group and no one in the other group; i.e., no similarity). Note that the maximum difference between groups in Figure 1 is 42. The closer the difference index is to 0, the more similar the principles required. Therefore, for this career field, considerable commonality exists even among the most dissimilar specialties. A measure of homogeneity (within-group overlap) is also shown in the figure. Within-group overlap is the average similarity of all specialties in a group. It uses the same similarity values that were used in the clustering.



Note. The numbers on the diagram are measures of homogeneity.

Figure 1. Cluster-Merger Diagram of Communications-Electronics Specialties.

Table 4 displays the correlations of the "percent of members using" each principle in the EPI for the Communications-Electronics specialties. The specialties are listed in descending order based on the mean number of specialty members using the principles. As might be expected from Figure 1, the correlations between some specialties are quite high.

Table 4. EPI Correlations Based on Percent Using for Communications-Electronics Specialties[a]

AFSC[b]	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
30250 (1)	93	88	76	79	81	88	86	70	73	93	74	34	80	78	74	86
30352 (2)		91	82	74	76	87	87	64	65	95	66	34	78	73	75	80
30351 (3)			83	70	76	83	84	70	68	89	57	32	69	65	71	75
30950A (4)				60	67	75	76	60	60	75	47	28	64	63	67	62
30251 (5)					86	79	83	84	85	76	81	34	76	77	73	86
30650 (6)						83	88	87	91	78	77	41	78	81	72	85
30451 (7)							89	70	72	85	66	42	82	86	78	87
30950B (8)								78	77	84	70	40	80	79	75	85
30554 (9)									94	68	75	36	61	64	60	68
30651 (10)										70	82	35	67	70	67	71
30353 (11)											73	42	80	76	78	80
30652 (12)												38	71	70	65	69
30750 (13)													49	46	51	40
30450 (14)														85	91	82
30454 (15)															76	89
30456 (16)																73
30455 (17)																

Note. Correlations greater than .06 significant at .05 level.
[a]Decimals omitted.
[b]The AFSCs are listed in sequence corresponding to the clustering results shown in Figure 1.

Although low correlations between two specialties would indicate that they are not good candidates for consolidation, high correlations do not necessarily indicate that two specialties should be consolidated. This is because correlations do not take level of use into account. Correlations reflect only the similarity of the pattern of EPI responses among specialties. Thus, an analysis of level of use of electronics principles must also be considered in making consolidation decisions. Table 5 displays the Communications-Electronics specialties in descending order based on mean number of principles used. The mean number of principles used indicates the average electronics principles load carried by journeyman airmen in the specialty. In addition, Table 5 shows the highest possible load within each specialty. The highest possible load is represented by the number of principles used by the combination of airmen in the specialty. A statistical analysis was performed to determine whether there were significant differences among specialties in the mean number of principles used. The analysis, a one-way analysis of variance, indicated that such significant differences do exist among the specialties ($F(16,5788) = 913.94$, $p < .005$).

Table 5. Use of Electronics Principles by Communications-Electronics Specialties

AFSC	Title	Number of Principles Used[a] Mean	SD	By Any[b]	Similarity of Means[c]				
30950A	Missile Det and Warning Radar Specialist	577 (46)	408 (32)	931 (74)	A				
30351	Air Traffic Control Radar Specialist	504 (40)	344 (27)	1125 (89)	A				
30352	Aircraft Control and Warning Radar Specialist	468 (37)	363 (29)	1114 (89)	A				
30250	Weather Equipment Specialist	466 (37)	365 (29)	1091 (87)	A	B			
30451	Navigational Aids Equipment Specialist	417 (33)	321 (26)	1055 (84)	A	B			
30456	Space Communications Systems Equipment Operator/Specialist	415 (33)	330 (26)	1145 (91)	A	B	C		
30455	Television Equipment Specialist	406 (32)	368 (29)	1012 (81)		B	C		
30950B	Space Surveillance Radar Specialist	368 (29)	336 (27)	926 (74)		B	C	D	
30454	Ground Radio Communications Specialist	336 (27)	322 (26)	940 (75)			C	D	
30251	Airborne MET/ARE Repair Specialist	336 (27)	388 (31)	506 (40)			C	D	E
30353	Automatic Tracking Radar Specialist	299 (24)	254 (20)	1044 (83)				D	E
30650	Electronic Communications and Cryptographic Equipment Systems Specialist	298 (24)	345 (27)	770 (61)				D	E
30450	Radio Relay Equipment Specialist	290 (23)	296 (24)	927 (74)				D	E
30651	Electronic-Mechanical Communications and Cryptographic Equipment Systems Specialist	272 (22)	344 (27)	678 (54)				D	E
30554	Electronic Computer Systems Specialist	271 (22)	315 (25)	735 (58)				D	E
30652	Telecommunications Systems/Equipment Maintenance Specialist	148 (12)	246 (20)	512 (41)					E
30750	Telecommunications Systems Control Specialist	59 (5)	125 (10)	259 (21)					

[a]Numbers in parenthesis are percentage of total possible (1,257).
[b]Based on principles used by 5% or more of the sample.
[c]Each column indicates groups with means not significantly different from one another based on Duncan's Multiple Range Test (Winer, 1971).

Analysis of Figure 1, and Tables 4 and 5, leads to the following suggestions regarding consolidations of Communications-Electronics specialties. First, it should be noted that 30554 and 30651 are the two most similar specialties in the sample. Next, 30250 and 30352 are quite similar. They could conceivably be grouped with 30351 and 30950A. Another group that should be considered is 30450-30454-30456-30455. Although 30251 and 30650 appear to be good prospects for merging, this group is not very promising, since 30251 has very few incumbents (sample N = 10). AFS 30353 correlates quite highly with 30250 and 30352; however, the mean number of principles used is considerably lower. It does not appear to be a good candidate for consolidation with any of the other specialties. Finally, the specialties 30652 and 30750 each have very low utilization of electronics principles. Consolidating either of those specialties with any of the other Communications-Electronics specialties could result in a considerably increased training load.

Wire Communications Specialties

The six Wire Communications specialties were analyzed for commonality with the same three techniques used for the Communications-Electronics specialties. Figure 2 shows the results of the hierarchical grouping analysis. Note that the maximum difference index, which ranges from 0 to 100, is 24. This is considerably smaller than the largest difference found among Communications-Electronics specialties. This is mainly due to the fact that the Wire specialties use fewer principles on the average than do Communications-Electronics specialties.

Table 6 displays the correlations of the "percent of members using" each principle in the EPI for the Wire Communications specialties. Unlike the correlations reported for the Communications-Electronics specialties, the correlations for the Wire specialties are rather moderate. Hence, although the differences in use of EPI principles are lower for Wire Communications than for Communications-Electronics specialties, the patterns of use show greater variation for Wire Communications than for Communications-Electronics specialties.

Table 6. EPI Correlations Based on Percent Using for Wire Communications Specialties[a]

AFSC[b]	36151	36251	36254	36252	36253
36150	66	57	54	22	39
36151		76	70	42	57
36251			93	63	82
36254				60	82
36252					76
36253					

Note. Correlation greater than .06 significant at .05 level.
[a]Decimals omitted.
[b]The AFSCs are listed in sequence corresponding to the clustering results shown in Figure 2.

Table 7 lists the Wire Communications specialties in descending order based on mean number of principles used. A one-way analysis of variance was performed to determine whether there were significant differences in the mean number of principles used among the specialties. Significant differences among the specialties were found ($F(5,679) = 52.36$, $p < .005$). Inspection of Table 7 indicates that 36252 has a much higher use of electronics principles than the other Wire Communications specialties and 36253 has a higher use than the remaining specialties.

Table 7. Use of Electronics Principles by Wire Communications Specialties

AFSC	Title	Number of Principles Used[a] Mean	SD	By any[b]	Similarity of means[c]	
36252	Electronic Switching Systems Specialist	299 (24)	342 (27)	813 (65)		
36253	Missile Control Communications Systems Specialist	175 (14)	287 (23)	500 (40)		
36251	Telephone Switching Equipment Specialist, Electromechanical	104 (8)	209 (17)	343 (27)	A	
36254	Telephone Equipment Installation and Repair Specialist	80 (6)	182 (15)	299 (24)	A	B
36150	Cable and Antenna System Installation/Maintenance Specialist	71 (6)	167 (13)	273 (22)	A	B
36151	Cable Splicing Installation and Maintenance Specialist	43 (3)	127 (10)	187 (15)		B

[a]Numbers in parenthesis are percentage of total possible (1,257).

[b]Based on principles used by 5% or more of the sample.

[c]Each column indicates groups with means not significantly different from one another based on Duncan's Multiple Range Test (Winer, 1971).

Analysis of Figure 2, and Tables 6 and 7, suggests that consolidations of several Wire Communications specialties may be possible. The most promising pair of specialties to be merged, based on the present data, would be 36251 and 36254. They are the only two specialties which are highly correlated. In addition, they are similar as to mean use of electronics principles and have the lowest difference index. A second pair of specialties that could be considered for merging is 36150 and 36151.

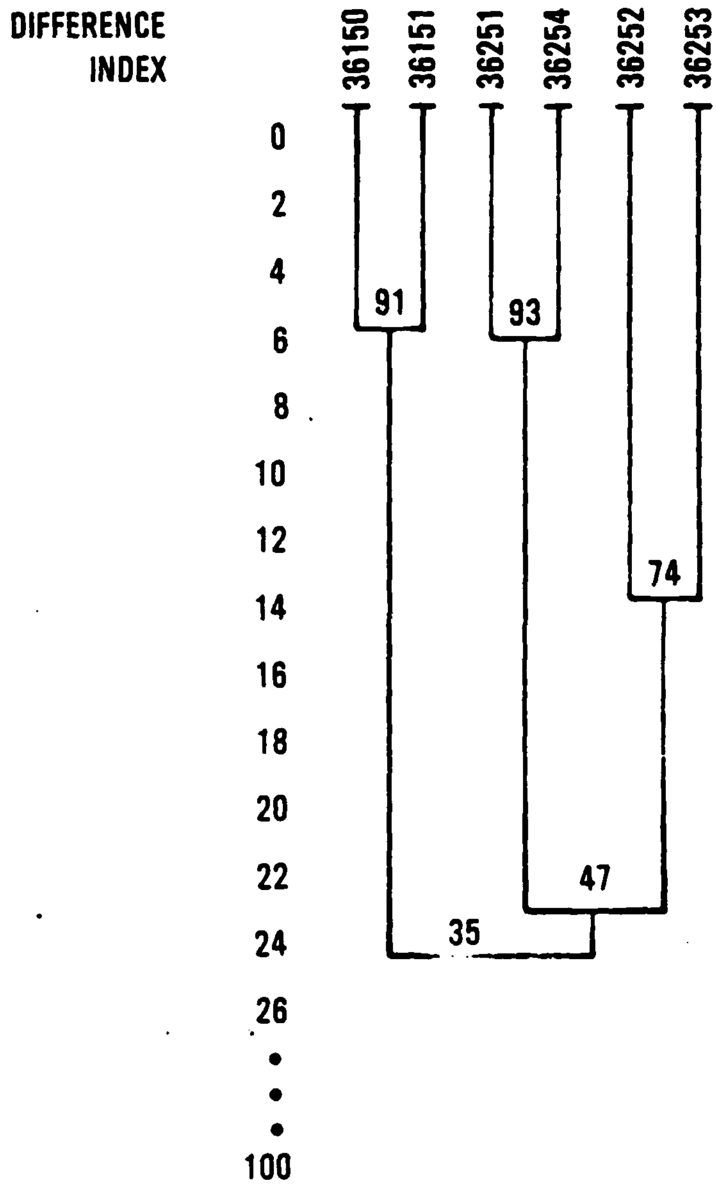
IV. DISCUSSION

A number of possibilities for consolidating electronics specialties emerged from this analysis. Comparing specialties on the basis of the underlying principles used on the job appears to be both a feasible and useful technique. Of course, it is limited in the sense that other factors such as manning, personnel, and training requirements must also be considered. Nevertheless, the results of the present study serve to focus the attention of analysts and decision makers on a limited subset of possible consolidations. The methodology provides Air Force managers with probable candidates for consolidation.

The results of the two sets of analyses yielded similar but not identical implications for AFS consolidation. More work would be required to distinguish which of the options are to be preferred. Present conclusions are based on a judgmental synthesis of the two analyses.

Force Management Implications

Although the focus of this study has been on the consolidation of specialties, the methodology has other practical applications. For example, a problem that the personnel managers



Note. The numbers on the diagram are measures of homogeneity.

Figure 2. Cluster-Merger Diagram of Wire Communications Specialties.

deal with continually is retraining. They wish to know which specialties are probable candidates for supplying airmen for other specialties so as to minimize retraining. Analysis of principle commonality among specialties would be particularly useful if the goal were to minimize the training requirements in transferring between specialties. Similarly, commonality analyses could be used in career planning or counseling. If an airman could not enlist in his or her first choice of specialty, specialties with high commonality could be offered as alternatives.

Commonality and Consolidation Considerations

When considering the feasibility of consolidating specialties, specific information concerning three personnel-related subsystems is required: the training, manning, and recruiting subsystems. An outline of the information that must be synthesized and analyzed in the process of making consolidation decisions is presented in Table 8. This paper has, up to now, dealt primarily with training. Discussion now turns to the remaining issues of concern.

Table 8. Considerations Relating to Consolidation of Specialties

Training	Manning	Recruiting
Equipment Similarity	Work Center Location	Recruiting Difficulty
Job/Task Similarity	Total Manning	Aptitude Requirements
Underlying Principles/ Knowledge Similarity	CONUS/Overseas Ratio	Attrition
	Unit Manning	

Manning. The considerations relating this methodology to manning are somewhat complex. At the unit level, certain specialties have been traditionally undermanned, while others receive priority manning. In the Communications-Electronics maintenance specialties, unit manning is critical because many positions, for example, require round-the-clock manning by fully qualified personnel. Units requiring only one specialty would not benefit from consolidation. However, units requiring more than one specialty on 24-hour duty should be analyzed and potential specialty combinations identified; those specialties which co-exist in such units would be good candidates for consolidation. Of course, a critical consideration is that "enough" job similarity exists. Another manning issue is CONUS/overseas ratios. Traditionally, specialties with high overseas imbalances have been suggested as candidates for merging with specialties that have high CONUS ratios. Again, such possibilities should be tempered with job similarity measures.

Recruiting. Recruiting considerations are quite difficult to use in making consolidation decisions. Specialties that are consolidated should have similar aptitude requirements. This would make sense both from the job requirement viewpoint and the recruiter's viewpoint. Consolidating specialties with differing aptitude requirements could increase the number of high-aptitude recruits required, an undesirable consequence from the recruiter's vantage point. The impact of recruiting difficulty and training attrition on consolidation decisions requires policy makers' and researchers' attention.

V. RECOMMENDATIONS

The following recommendations can be made as a result of this research:

1. The methodology may be used to quantify skill/knowledge overlap as a part of specialty consolidation decisions. The methodology includes the development and application of principles or skills-knowledge inventories and analyses of resultant data.

2. The following specialties appear to have sufficiently substantial similarity in underlying skills and knowledge requirements to warrant serious consideration for consolidation:

   a. 30554 and 30651

   b. 30250 and 30352

   c. 30250, 30352, 30351, and 30950A

   d. 30450, 30454, 30456, and 30455

   e. 36251 and 36254

   f. 36150 and 36151

3. Subsequent analyses should be performed on the recommended groupings of specialties to provide operational information in terms of common tasks performed, ease of cross-training, work center manning, initial training difficulty, recruiting difficulty, and expected equipment changes. Such analyses could be performed using data provided by the USAF Occupational Measurement Center, the USAF Military Personnel Center, and ATC, as well as HQ USAF and Major Command functional managers.

4. The technology should be incorporated in future research on the development of Air Force skills-knowledge inventories, and in research on occupational transferability.

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