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Decision Procedures in Transit Station Design

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EXECUTIVE SUMMARY

A. Introduction

Prior to the mid 1970's, the processes of the planning and design of public transportation terminals were generally unsystematic. Various "tricks of the trade" and "rules of thumb" existed, but these often differed for different transit systems. Isolated regulations and policies guided design in several systems, but there was little uniformity across systems and often no compelling rationale behind the regulations. Some design decisions were dictated by professional standards. However, no standard methodology was available to guide the designer in his or her task.

A major conference on transit station design, held in 1975, brought together experts in several related fields (planners, operators, engineers, architects, and designers) to assess the state of the practice in station design and identify problems for further study and research.

As one consequence of the Carnegie Mellon conference, a major research effort on transit station design was undertaken at the University of Virginia. This project has resulted in a systematic methodology for the design and renovation of public transportation terminals [2], a procedural guide for the design of transportation interface facilities [3] and a set of criteria for evaluating alternative transit station designs [4]. The methodology has been applied in case studies of both new terminal construction [5] and the renovation of an existing transit facility [6]. In addition, the special problems of designing stations for passenger security have been examined in detail [7].

As described in the University of Virginia methodology, transit station planning and design involves decision-making at several levels: 1) the initial constraints or specifications (policy directives) for the station are generally decided prior to the design proper, 2) particular station designs (configurations) are generated as a result of choices among alternative values for design variables (attributes), 3) the success or "goodness" of a particular design is evaluated by combining various performance and acceptance measures, taking account of their relative importance, and 4) the choice of a particular design for eventual construction often follows from a process of trading off various alternative designs and political realities.

B. Problems Studied

This report addresses two primary types of decision problems in the Station Design Process: the first is how to generate or develop one or more candidate designs for a transit station at a particular site; the second is how to choose the best design from a set of candidates.

The process of generating or developing a candidate design requires that the designer consider a variety of design features and specify particular values of those features. A formal description of this process would allow the designer to cycle through the various design considerations in the most efficient and complete manner. The primary questions here are how early in the design process must each element be considered, and which decisions depend on others made during the design process? Thus, this decision procedure will involve priority assessment or the determination of the ordering of various design stages.

The process of choosing the best design from a set of candidate designs is conceptually simpler. A set of evaluation criteria must be specified and the various designs evaluated in terms of those criteria. Then, it is necessary to determine weights (importance indices) for the various evaluation criteria so that those criteria may be combined to yield a single measure used to reach a final decision. Proposed criteria and possible ways of measuring each were presented in earlier reports. In this research, estimates of the importance of various design elements to the overall success of a station design are obtained.

C. Results Achieved

Two kinds of results were presented in this paper: first the results of a conceptual analysis of the station design process are presented in Section II; then the results of a survey of transit station design professionals are presented in Sections III-VI. A preliminary description of terminal planning and design has been formulated which orders the steps involved in the design process and identifies the decisions and alternatives involved at each step. The steps in the design process as formalized here are:

1) Policy Development
2) Site Selection

3) Preliminary System Demand Evaluation
4) Translation of Policy and Demand into Initial Design Requirements
5) Reevaluation of Demand Estimates
6) Derivation of Area Requirements and Assessment of Site Sufficiency
7) Establishment of Alternative Architectural Plans
8) Evaluation of Adherance to Policy
9) Evaluation of Cost and Performance of Alternative Designs
10) Selection of Best Alternative
11) Improvement of Best Alternative if Indicated by Evaluation

Each step in the process requires multiple decisions. This description provides a map to guide the designer through the various design considerations in an efficient and non-repetitious manner.

The survey on station design was conducted at the National Conference on the Planning and Development of Public Transportation Terminals held in Silver Spring, Maryland on September 21-24, 1980. Of the 137 registered participants at the conference, about 100 of these took part in the workshops. Useable questionnaires were returned by 89 workshop participants. After they provided basic personal and demographic information, respondents were asked to indicate which interest groups (management, designer/planner/architect, or federal or local government) they felt should be primarily responsible for decisions regarding each of twelve (12) station features (components). They were also asked to rate the priority they felt each of sixteen (16) design elements should have in the overall station design process. Finally, the respondents judged the relative importance of each of nineteen (19) criteria to the overall success of a station design.

There was general agreement among the respondents that decisions concerning security, concessions and advertizing should be made by transit management. Station layout and architectural design were viewed as the domain of the designer/architect/planner. Joint development, station location and provisions for the handicapped were attributed about equally often to each of three interest groups (management, designers, and local government), and thus joint decisionmaking responsibility is indicated here. The final design selection is the responsibility of management. These respondents saw little role for the federal government in the transit station design process.

Respondents rated the priority in the overall design process of several design elements. The instructions for this task specified that priority implies temporal ordering: high priority elements would be considered first, low priority items last. Station access, location of entry and exit points, number of passengers accommodated, fare collection, and the characteristics of passenger flow were assigned the highest priorities in the design process.

The importance of various criteria to the success or evaluation of a station design was also indicated by these respondents. Passenger safety and security, efficiency of passenger movement, and level of crowding were rated the most important; concessions and advertising were the least important.

D. Utilization of Results

These results reveal how professional designers and managers view the priorities of particular design considerations in the overall process of generating a station design and the importance of criteria in evaluating various designs and selecting a "best" alternative. Individual designers may use these results to evaluate and reconsider their current design practices. New designers may use them as prescriptions for practice: the design priorities indicate which elements should be considered first in generating a design; the criterion importance weights tell which measures must be optimized for eventual design success. The multiattribute linear model may be employed to evaluate design alternatives, given the appropriate measures for each station.

E. Conclusions

Two preliminary decision procedures have been discussed in this report: a sequential decision model for transit station design and a multiattribute linear model of design evaluation. Data related to aspects of those models were gathered from participants at a National Conference on Transit Station Design. Nearly a hundred attendees responded to a questionnaire distributed at the conference. These respondents indicated who they thought should have primary responsibility for various design decisions, judged the priorities of selected decisions in the overall design process, and rated the importance of several criteria in evaluating the success of a station design.

ACKNOWLEDGEMENT

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I. DECISION PROBLEMS IN TRANSIT STATION DESIGN

Prior to the mid 1970's, the processes of the planning and design of public transportation terminals were usually intuitive and generally unsystematic. Various "tricks of the trade" and "rules of thumb" existed, but these often differed for different transit systems. There were also isolated regulations and policies guiding design in several systems, but again there was little uniformity across systems and no compelling rationale behind the regulations. Finally, some design decisions were dictated by professional standards. No guidebook, manual or standard methodology was available to guide the designer in his task.

This state of affairs was clearly identified as problematic at a major conference on transit station design held in 1975 [1]. That conference brought together experts in several related fields (planners, operators, engineers, architects, and designers) to assess the state of the practice in station design and to identify problems for further study and research.

One consequence of the Carnegie Mellon conference was the conception of a major research effort on transit station design undertaken at the University of Virginia. This project has resulted in a systematic methodology for the design and renovation of public transportation terminals [2], a procedural guide for the design of transportation interface facilities [3] and a set of criteria for evaluating alternative transit station designs [4]. The methodology has been applied in case studies of both new terminal construction [5] and the renovation of an existing transit facility [6]. In addition, the special problems of designing stations for passenger security have been examined in detail [7].

As described in the University of Virginia methodology, transit station planning and design involves decision-making at several levels: 1) the initial constraints or specifications (policy directives) for the station are generally decided prior to the design proper, 2) particular station designs (configurations) are generated as a result of choices among alternative values for design variables (attributes), 3) the success or "goodness" of a particular design is evaluated by combining various performance and acceptance measures, taking account of their relative importance, and 4) the choice of a particular design for eventual construction often follows from a process of trading off various alternative designs and political realities. Thus, the levels may be characterized as involving 1) policy directives, 2) features or design variables, 3) criteria or evaluation variables, and 4) principles of choice or optimization (including tradeoffs). This report incorporates all four levels of concern into two preliminary decision procedures for transit station design.

Decision Problems in the Station Design Process

There are two primary types of decision problems in the Station Design Process: the first is how to generate or develop one or more candidate designs for a transit station at a particular site; the second is how to choose the best design from a set of candidates. This latter problem is basically how to evaluate the design of a transit station. Thus, we can distinguish a model of the steps in developing a station design from one for the evaluation of the success of a design.

The process of generating or developing a candidate design requires that the designer consider a variety of design features and select particular values of those features. A formal description of this process would allow the designer to cycle through the various design considerations in the most efficient and complete manner. A series of decisions and options would be considered, and the independence or dependence (contingencies) of the various decisions would be incorporated into the description. Certain criteria, policies or standards may have to be satisfied and these should be reflected in the procedure. The primary questions here are how early in the design process must each element be considered, and which decisions depend on others made during the design process? Thus, this decision procedure will involve priority assessment or the determination of the ordering of various design stages.

The process of choosing the best design from a set of candidate designs is conceptually simpler. Here a set of evaluation criteria must be specified and the various designs evaluated in terms of those criteria. Then, it is necessary to determine weights (importance indices) for the various evaluation criteria so that those criteria may be combined to yield a single measure used to reach a final decision. A proposed set of criteria and possible ways of measuring each were presented by Demetsky and Hoel [8]. Given a matrix of measures such as they propose, a set of weights for each of the measures (criteria) would be necessary to allow their combination so that an overall evaluation of the design could be achieved. Thus, we need an importance structure for the various criteria of performance and acceptance.

The distinctions between these two types of problems are thus: 1) the issue of generation versus evaluation of a design, and 2) concern for features of the station design versus the results or consequences of the design.

Varieties of Decision Models

There are many types of decision models available in the literature; these include utility theory, game theory and various optimization theories [9], regression models [10], multiattribute policy models [11], interactive sensitivity analysis [12], and trade off analysis [13]. In addition, various computer models of decision processes have been advocated [14].

The two procedures proposed here are relatively simple. Each is appropriate to the quality of data and level of sophistication achieved to date in dealing with the relevant design problem.

A sequential decision making procedure is proposed for generating transit station designs. The quantification here will be simply a set of priority weights to guide the ordered consideration of various decisions. The primary purpose of such a model is to facilitate the designer's (engineer or architect) consideration of the design issues in the optimal order. In such a scheme, choices or decisions made at early stages may constrain later ones. The earliest choices should be the most important or far reaching ones, while less important choices are made later in the process, and may thus be less flexible. The ultimate form of such a model would be an interactive computer program leading the designer through a sequence of decisions so as to optimize the design properties.

The evaluation of a particular station design or the comparison of alternative designs will be accomplished using rational linear equations. These equations involve additive combinations of many variables (or measures) with weights for each measure to reflect its relative importance. The variables in the model are the evaluation measures. They reflect either the performance (cost, passenger volume, etc.) or acceptance (security, comfort, environmental quality, etc.) of the station. Simple linear equations are used because 1) insufficient data exists to separate them from more complex models, and 2) they will provide a good first approximation from which to develop subsequent, more elaborate models.

Purposes of this Research

This report describes some initial steps toward developing decision procedures for transit station design and evaluation. In the next section, a preliminary description of terminal planning and design has been formulated which orders the steps involved in the design process and identifies the decisions and alternatives involved at each step. The purpose of this procedure is to guide the designer through the important decisions described in the Methodology for the Design of Urban Transportation Interface Facilities [2] and the Procedural Guide for the Design of Transit Stations and Terminals [3]. The steps in the design process as formalized here are:

1) Policy Development
2) Site Selection
3) Preliminary System Demand Evaluation
4) Translation of Policy and Demand into Initial Design Requirements
5) Reevaluation of Demand Estimates
6) Derive Area Requirements and Assess Site Sufficiency
7) Establish Alternative Architectural Plans
8) Evaluate Adherance to Policy
9) Evaluate Cost and Performance of Alternative Designs
10) Select Best Alternative
11) Improve Best Alternative if Indicated by Evaluation

Each step in the process requires multiple decisions. This description provides a map to guide the designer through the various design considerations in an efficient and non-repetitious manner.

The results of a survey of transit station planners and designers are then presented. This survey was conducted to obtain data from professionals about their perceptions of the current relative priorities of selected design decisions and about the relative importance of various design elements to the success of a station. Thus, this survey provides information relevant to both kinds of decision procedure.

This report is intended for designers, planners, and policy makers as well as research workers. The research audience requires a description of the data and the statistical tests conducted using them; the practitioner is primarily concerned with the results and their implications for design. In order to satisfy both audiences, each statistical test is accompanied by a brief description of its general purpose. The details of the tests may not interest the general reader, but their results and implications are valuable for anyone concerned with transit station design.

II. DECISION STRUCTURE FOR TRANSIT STATION DESIGN

Ideally, decisions regarding the design of a particular transit station should follow from a detailed and complete understanding of the station design process. A methodology for transit station design has been described previously [2, 3, 4, 5, 6]. An expanded version of this methodology is illustrated, as an ordered sequence of steps, in Figure 1. The particular ordering of the decisions may be altered depending on local requirements and politics. Within each of the discrete steps, various specific design decisions are made. These are described below.

STEP 1. POLICY DEVELOPMENT

The adoption of a set of policy goals lays the foundation for nearly every subsequent step in the design process. Five main sources contribute to the development of policy:

(1) Federal government
(2) State government
(3) Local government/transit authority
(4) Professional standards
(5) Past experience

The particular concerns of each are indicated in Figure 2.

STEP 2. SITE SELECTION

The selection of a site is based on a number of considerations including:

(1) Ridership potential,
(2) Accessibility to major corridor or expressway,
(3) Accessibility to local walk, auto, and bus travel,
(4) Compatibility with surrounding land use,
(5) Current use of site,
(6) Size of site,
(7) Potential for site expansion, and
(8) Cost of construction.

Site selection is often determined in the political arena with input from transit management, designer/planner and local government. This step of the

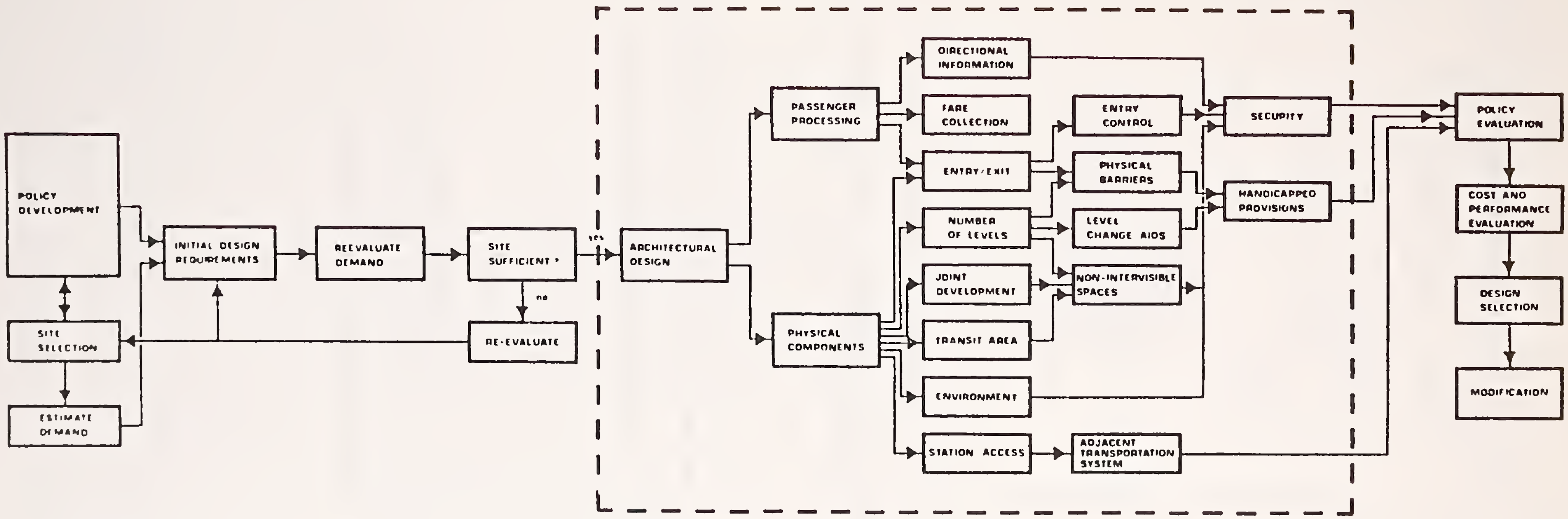

Figure 1. Transit Station Design Process

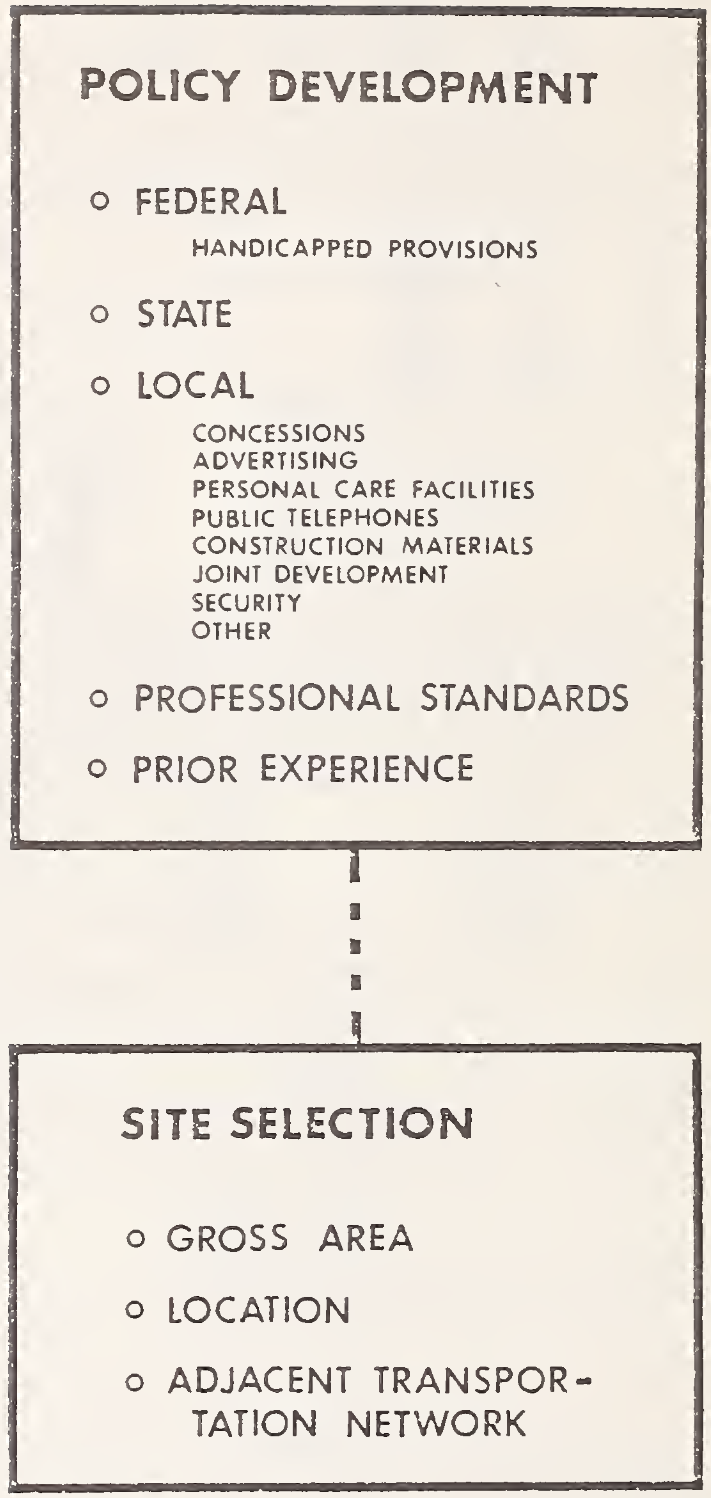

Figure 2. Policy Development and Site Selection

design process is illustrated in Figure 2. The dashed line between site selection and policy development represents the direct impact of policy on site and, conversely, site on policy.

STEP 3. PRELIMINARY SYSTEM DEMAND EVALUATION

Following the selection of a site, the planning team must derive preliminary demand estimates. The design of transit stations requires adequate forecasts of transit ridership including daily demand, peak hour demand, and the distributions of demand by day, month, and season.

Additionally, it is essential that approximate access and egress mode volumes be known, and that estimates of the number of elderly and handicapped users be available. These two groups may require special facilities or accommodations which will constrain the design options. This step is illustrated in Figure 3.

PRELIMINARY STATION DEMAND

- o VOLUME (TOTAL, PEAK-HOUR, ETC.)
- o MODE SPLIT (ACCESS AND EGRESS)
- o SPECIAL USER (E&H)

Figure 3. Estimation of Preliminary Station Demand

STEP 4. TRANSLATION OF POLICY AND DEMAND INTO INITIAL DESIGN REQUIREMENTS

Combining the results of Step 1, policy development, and Step 3, preliminary demand estimates, the station design team, which may include engineers, architects, operators, and maintenance people as well as management and political figures, develops various initial design requirements. The most prominent early decisions involve provisions for the elderly and handicapped and whether or not to accommodate joint development. The first of these is guided by current federal regulations, while joint development is usually established by local policy goals. The degree of joint development can range from a few concessions to an elaborate complex of station, office and shopping facilities. This step is illustrated in Figure 4.

TRANSLATE POLICY/DEMAND INTO INITIAL DESIGN REQUIREMENTS

- o JOINT DEVELOPMENT
- o HANDICAPPED PROVISIONS
- o OTHER

Figure 4. Translation of Policy and Demand Into Initial Design Requirements

STEP 5. <u>REEVALUTION OF DEMAND ESTIMATES</u>

Once the initial design requirements have been formulated, the original demand estimates may be altered to reflect those decisions. For example, the decision to accommodate joint development could have a significant impact on the number of persons accessing the site. The trips generated due to the joint facilities must be coupled with transit demand to arrive at an adequate prediction of total facility volumes. This is illustrated in Figure 5.

RE-EVALUATE STATION DEMAND

- o TOTAL VOLUME
- o SPECIAL USERS
- o JOINT DEVELOPMENT GENERATION
- o ACCESS/EGRESS MODE SPLIT

Figure 5. Reevaluation of Station Demand

STEP 6. <u>DERIVATION OF AREA REQUIREMENTS AND SITE SUFFICIENCY</u>

Figure 6 illustrates the sixth step in the station design process. With the adjusted demand estimates, unit area requirements (ft^2) can be derived for each of the station components. These components include:

(1) Parking facilities
(2) Fare collection activities
(3) Waiting areas
(4) Platform areas
(5) Operational functions (mechanical, etc.)
(6) Transit areas
(7) Personal care facilities
(8) Future expansion
(9) Other

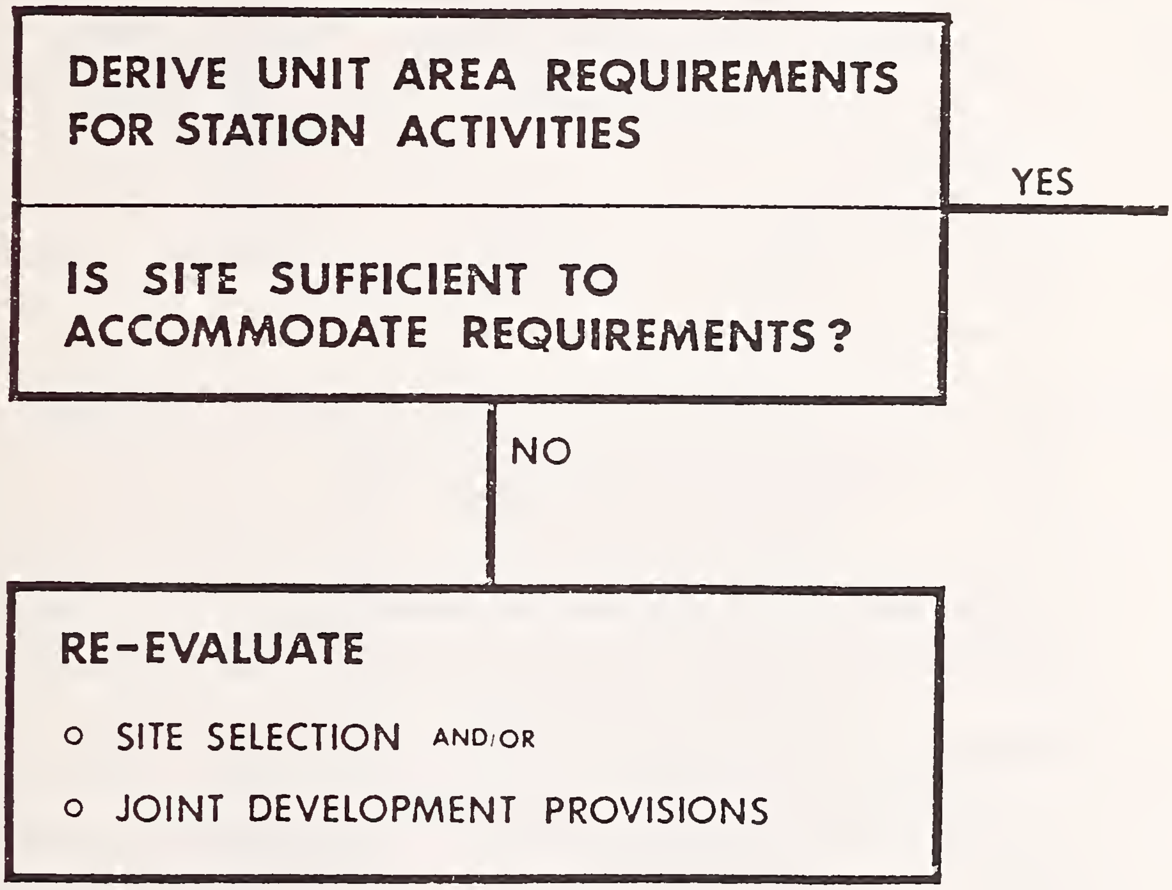

Figure 6. Determination of Site Sufficiency

The sum of these areas is then compared to the size of the site to determine the site's sufficiency to accommodate all of the necessary station activities. If the site is acceptable in this respect, the design process can continue unimpeded. However, if the site is not sufficient and activities cannot be feasibly distributed among an appropriate number of levels, reevaluation of either the site itself or the provisions for joint development is necessary. In either case, demand estimates must be reevaluated and the design process restarted at Step 2 or Step 4 as necessary.

STEP 7. ESTABLISH ALTERNATIVE ARCHITECTURAL PLANS

Once the sufficiency of the site has been established, the design team (architect/engineer) can develop alternative station layouts. This generation of designs is represented by all of the activities or elements contained within the dashed-line box in Figure 1. Each pass through this box yields a single station design; several alternative designs will require several passes through the box.

This step in the design process has the greatest involvement of decision-making. Nearly all decisions, except those of policy, are included in the establishment of alternative architectural plans. This step serves to decompose architectural design into a large number of individual design elements or considerations. Additionally, this decomposition and the illustration of the element interrelationships allow the designer to better understand the type and number of decisions involved as well as the consequences or implications of each decision.

In establishing alternative layouts, the two primary classes of design considerations are passenger processing and physical components. These are illustrated in Figure 7. Along the passenger processing path, there are three primary design implications as shown in Figure 8. Likewise, the physical components path leads into six different subcategories as illustrated in Figure 9. The location and number of entry/exit points are influenced by both the passenger processing and physical component considerations. Although other physical components may impact passenger processing, they primarily affect the structural layout, and thus have been included only in the physical component category.

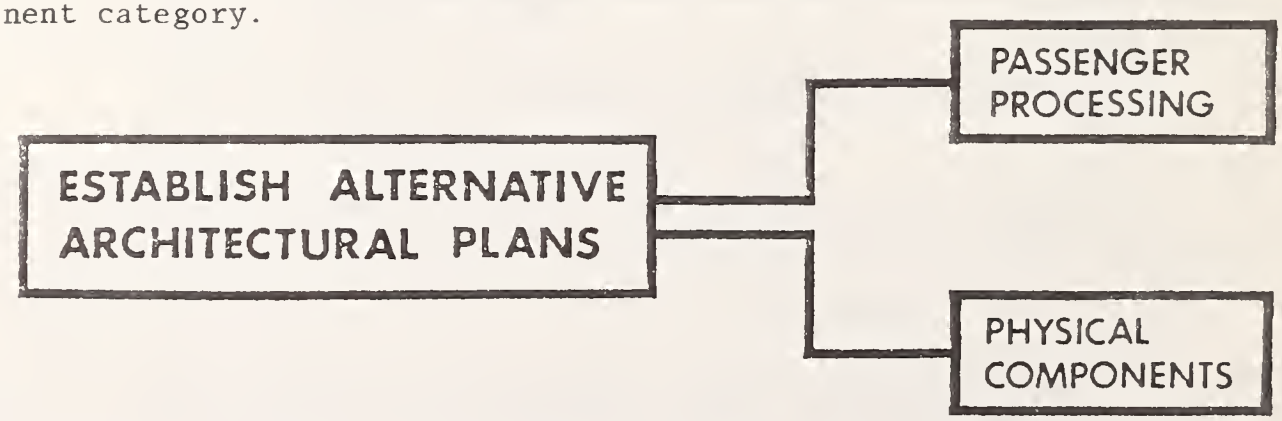

Figure 7. Basic Components in Development of Architectural Plans

The eight individual implications illustrated in Figure 8 and 9 interact in a number of ways to provide the design team with five additional considerations. These interactions are illustrated in Figures 10 a-e. For example, in Figure 10d, fare collection and the location and number of entry/exit points converge to influence entry control. In other words, decisions regarding fare collection and/or the location number of entry/exit points may influence later decisions about entry control.

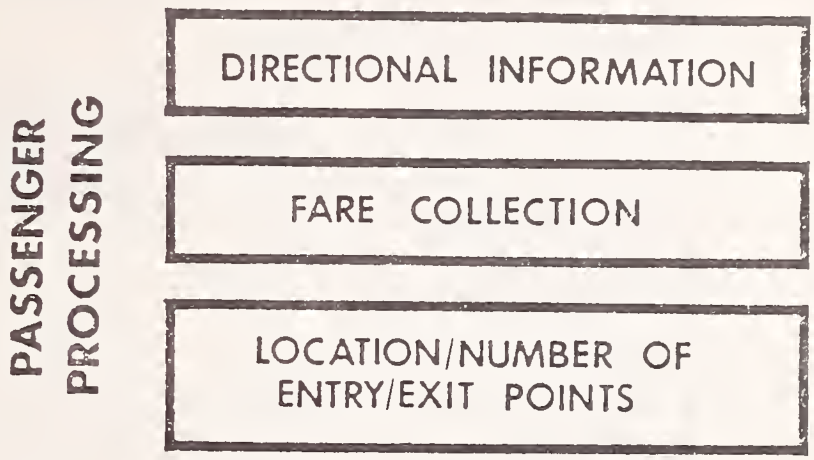

Figure 8. Elements Considered in Passenger Processing Design

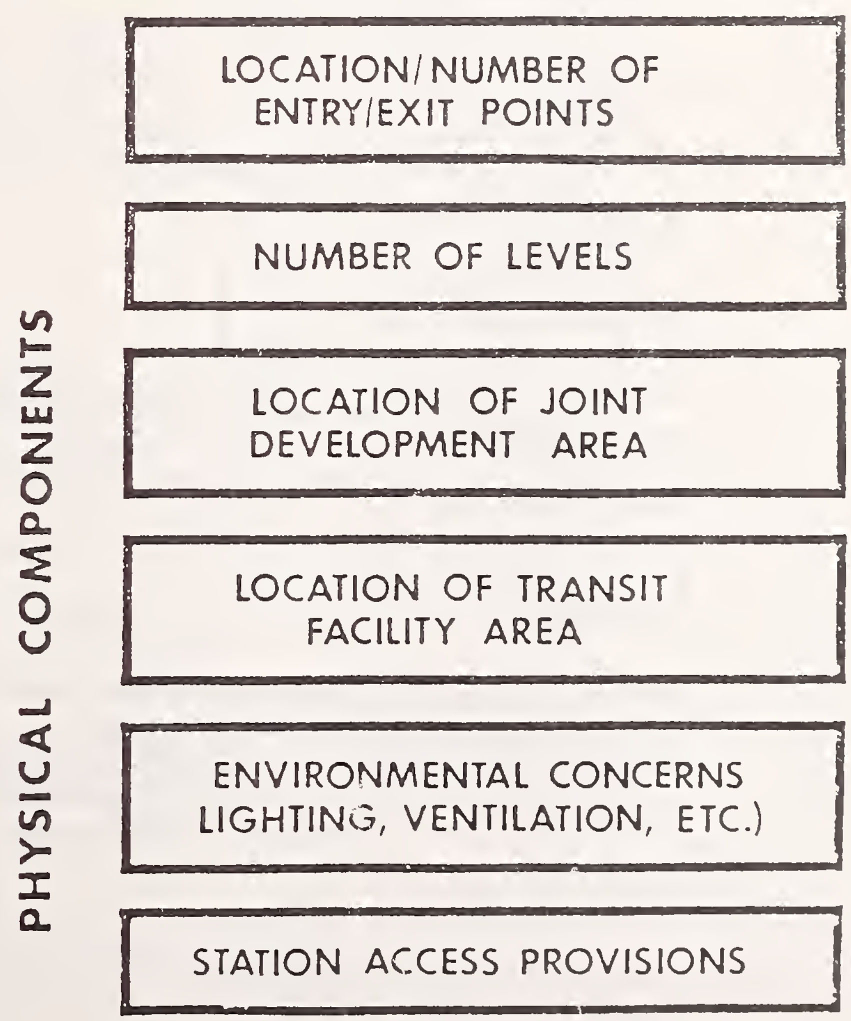

Figure 9. Elements Considered in Physical Components Design

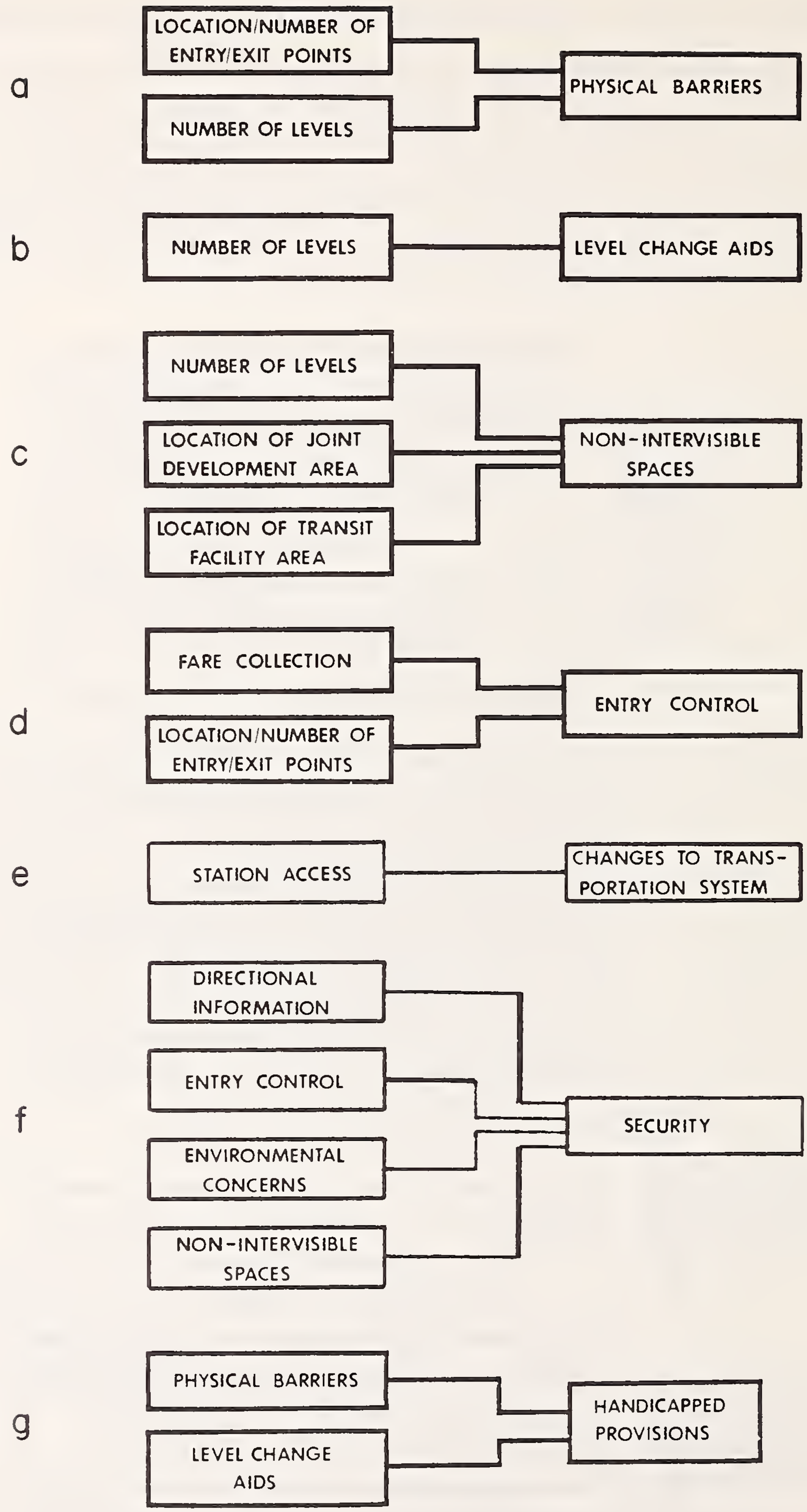

Figure 10.(a-g). Interactions of Variables in the Transit Station Design Process

The remaining considerations, directional information and environmental concerns, combine with the aforementioned implications to arrive at two major station design components, security and provisions for the handicapped. These combinations are illustrated in Figure 10f and 10g.

This completes the generation of a station layout, and design. As stated before, the order of these design elements is not absolute. For example, accommodations for handicapped persons can be considered first as a policy matter.

STEP 8. POLICY EVALUATION

As illustrated in Figure 11, the first step in the evaluation process is to determine whether each design adheres to the policy set at the initial state in the design process. If all policy requirements are met, evaluation can continue. If policy is violated, the alternative can be rejected, the design altered to meet policy requirements, or policy altered to permit the design to be considered.

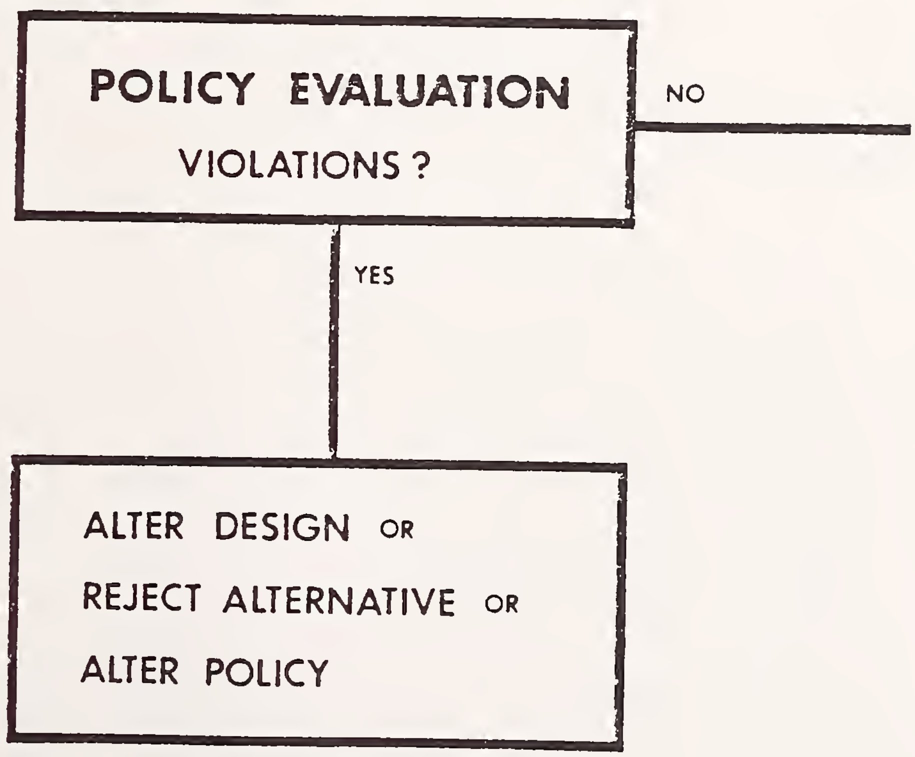

Figure 11. Policy Evaluation

STEP 9. EVALUATION

Once a set of alternative designs has been processed through Step 8, the evaluation procedure requires comparison of cost and performance among alternative designs. The methods used for this evaluation have been detailed in earlier reports [2, 3, 4, 8].

STEP 10. FINAL DESIGN SELECTION

Based on the cost and performance evaluations, the planning team selects the best or most appropriate station design from among the several alternatives. After selection of a final design, certain modifications may be necessary or desirable. This final step allows for those changes provided they do not alter the results of the evaluation process.

III. SURVEY ON STATION DESIGN

A questionnaire was distributed to workshop participants at the National Conference on the Planning and Development of Public Transportation Terminals that was held in Silver Spring, Maryland on September 21-24, 1980. Of the 137 registered participants at the conference, about 100 of these took part in the workshops. Useable questionnaires were returned by 89 participants. The questionnaire as administered is shown in Appendix A. The survey was conducted by Mr. Douglas M. McCants as part of the work for his M.S. degree. Funding for the actual survey work was independent of this contract.

After they provided basic personal and demographic information, respondents were asked to indicate which interest groups (management, designer/planner/architect, or federal or local government) they felt should be primarily responsible for decisions regarding each of twelve (12) station features (components). They were also asked to rate the priority they felt each of sixteen (16) design elements should have in the overall station design process. Finally, the respondents judged the relative importance of each of nineteen (19) criteria to the overall success of a station design. Standard statistical procedures were used in the evaluation of the questionnaire responses. SPSS (Statistical Package for the Social Sciences) was used to generate these statistics. [15]

A diverse group of participants attended the conference as indicated in Table 1. This group probably is representative of the set of people concerned with transit station design in the United States. The number of people who are involved in the details of transit station design nationally is relatively small. Since the size of this target group is limited, it is probably well-represented by these participants. These are mostly people who actually do the planning and design of transit stations. Many of the people have worked for several transit authorities and have designed stations for more than one travel mode. Thus, although this was a sample of convenience, it probably provides a good representation of station planners and designers in general. Management positions accounted for nearly one-third of all participants. One-fourth of the respondents classified themselves as system planners. These were followed in number by architects, designers, and operations personnel. The category "other", representing about one-sixth of the responses, is composed of 7.2% who indicated their positions fall into more than one category and 9.5% who are employed in such fields as research, planning, analysis (software), and government.

Table 1. Current Job of Questionnaire Respondents

Current Job	Per Cent of Respondents
System Planner	23.8
Architect	10.7
Management	31.0
Design	10.7
Operations	4.8
Political	1.1
Maintenance	1.2
Other	16.7

The areas of formal training also showed a wide diversity of reponses. Over a third of the respondents, though, indicated their training was in civil engineering. Table 2 shows the tabulated responses. When the responses classified as "other" are examined, nearly half of them (13.9%) are individuals with training in more than one area; the remainder (16.3%) have training in areas ranging from other engineering disciplines and mathematics to the more humanistic fields of psychology, political science, sociology, economics, art, and English.

Of particular interest was whether or not the respondents had been actively involved in the planning and design of transit stations. Of those responding, 69.7% indicated they had been so involved while the remaining 30.3% had not. Those persons with planning and design experience were asked the length of their involvement and what types of systems they had worked on. Table 3 shows the breakdown of the number of years of involvement in planning and design. The mean response was 6.6 years with the wide variation of response reflected in a standard deviation of 6.6 years. These respondents have generally participated in the planning and design of more than one type of transit system, as indicated in Table 4.

Table 2. Respondents' Areas of Formal Training

Area of Formal Training	Per Cent of Respondents
Mechanical Engineering	4.7
Civil Engineering	37.2
Finance	1.2
Business	8.1
City Planning	3.5
Architecture	15.1
Other	30.2

Table 3. Respondents' Years of Experience in Planning and Design

Number of Years in Planning and Design	Per Cent of Respondents
1	21.2
2	18.2
3-5	18.2
6-10	21.2
11-15	10.6
16-20	7.6
20	3.0

Table 4. Proportion of Respondents Working on Various Types of Systems

Type of System	Per Cent of Respondents
Urban Rapid Rail	20.9
Regional Rail	4.5
Bus	14.9
More than one of above	58.2
Other	1.5

IV. PERCEPTIONS OF RESPONSIBILITY FOR DESIGN DECISIONS

The participants were asked to decide who they felt should be primarily responsible for decisions regarding each of twelve (12) design components. Since the items asked who should be primarily responsible, responses indicating more than one person or group were considered invalid. The number of invalid or blank responses is indicated in each of the tables below. The proportions in each table represent only the valid responses. Table 5 shows the attribution of decisionmaking responsibilities for the entire group of respondents. Tables 6, 7, 8 and 9 show responses from particular subgroups: system planners, architects, management, and designers, respectively. Because of the relatively small sample sizes for architects and designers, their similar interests, and generally similar responses, these two groups were combined and the results are shown in Table 10.

In indicating primary responsibility for design decisions, the respondents revealed somewhat different opinions depending upon their occupation. In general, a respondent tended to believe that his (or her) own occupation should have greater responsibility for design decisions. However, the same patterns of decisionmaking responsibility are evident for each group (Tables 6, 7, 8, 9 and 10; the double asterisks (**) indicate which groups received 70% or more of the responses). Overall, there is general agreement that transit management should have primary responsibility for security, concessions, and advertising, while the designer/architect/planner should be primarily responsible for station layout and architectural design. The final design selection is also usually judged as the responsibility of management. All other components seem to require joint decisionmaking responsibility.

Table 5. Statistics for Decisionmaking Responsibility (All Occupations)

Design Component	% Indicating: Transit Management	Designer Planner Architect	Local Government	Federal Government	Number not Responding or Invalid Response
Handicapped Accommodations	30.9*	25.0*	32.4*	11.8	20
Security Provisions	76.6**	14.1	7.8	1.6	24
Concessions	88.9**	6.9	4.2	0	16
Advertising	91.5**	7.0	1.4	0	17
Joint Development	28.1*	26.6*	42.2*	3.1	24
Station Layout	19.0	81.0**	0	0	25
Personal Care Facilities	49.3*	47.8*	1.5	1.5	21
Station Size	35.3*	63.2*	1.5	0	20
Station Location	27.4*	38.7*	33.9*	0	26
Architectural Design	4.3	92.8**	2.9	0	19
Internal Environmental Standards	20.6	60.3*	13.2	5.9	20
Final Design Selection	62.9*	19.4	17.7	0	26

** $\geq$ 70% responding

* $\geq$ 25% responding

Table 6. Statistics for Decisionmaking Responsibility (System Planners)

Design Component	% Indicating: Transit Management	Designer Planner Architect	Local Government	Federal Government	Number not Responding or Invalid Response
Handicapped Accommodations	31.3*	31.3*	37.5*	0	3
Security Provisions	71.4*	21.4	7.1	0	5
Concessions	88.2**	5.9	5.9	0	2
Advertising	100.0**	0	0	0	3
Joint Development	0	26.7*	73.3*	0	4
Station Layout	30.8*	69.2*	0	0	6
Personal Care Facilities	37.5*	56.3*	6.3	0	3
Station Size	25.0*	75.0**	0	0	3
Station Location	21.4	35.7*	42.9*	0	5
Architectural Design	0	87.5**	12.5	0	3
Internal Environmental Standards	18.8	43.8*	25.0*	12.5	3
Final Design Selection	53.3*	13.3	33.3*	0	4

** $\geq$ 70% responding

* $\geq$ 25% responding

Table 7. Statistics for Decisionmaking Responsibility (Architects)

Design Component	% Indicating: Transit Management	Designer Planner Architect	Local Government	Federal Government	Number not Responding or Invalid Response
Handicapped Accommodation	20.0	60.0*	20.0	0	4
Security Provisions	80.0**	20.0	0	0	4
Concessions	60.0*	40.0*	0	0	4
Advertising	50.0*	50.0*	0	0	5
Joint Development	40.0*	60.0*	0	0	4
Station Layout	0	100.0**	0	0	3
Personal Care Facilities	16.7	83.3**	0	0	3
Station Size	0	100.0**	0	0	4
Station Location	0	80.0**	20.0	0	4
Architectural Design	0	100.0**	0	0	3
Internal Environmental Standards	0	100.0**	0	0	4
Final Design Selection	60.0*	40.0*	0	0	4

** $\geq$ 70% responding

* $\geq$ 25% responding

Table 8. Statistics for Decisionmaking Responsibility (Management)

Design Component	% Indicating: Transit Management	Designer Planner Architect	Local Government	Federal Government	Number not Responding or Invalid Response
Handicapped Accommodations	42.1*	42.1*	15.8	0	7
Security Provisions	95.0**	0	5.0	0	6
Concessions	90.5**	0	9.5	0	5
Advertising	95.5**	0	4.5	0	4
Joint Development	30.0*	30.0*	40.0*	0	6
Station Layout	20.0	80.0**	0	0	6
Personal Care Facilities	63.2*	36.8*	0	0	7
Station Size	57.1*	42.9*	0	0	5
Station Location	50.0*	25.0*	25.0*	0	6
Architectural Design	10.0	90.0**	0	0	6
Internal Environmental Standards	26.3*	52.6*	21.1	0	7
Final Design Selection	78.9**	5.3	15.8	0	7

** $\geq$ 70% responding

* $\geq$ 25% responding

Table 9. Statistics for Decisionmaking Responsibility (Designers)

Design Component	% Indicating				Number not Responding or Invalid Response
	Transit Management	Designer Planner Architect	Local Government	Federal Government	
Handicapped Accommodations	11.1	33.3*	33.3*	22.2	0
Security Provisions	71.4*	14.3	14.3	0	2
Concessions	88.9**	11.1	0	0	0
Advertising	88.9**	11.1	0	0	0
Joint Development	50.0*	25.0*	12.5	12.5	1
Station Layout	0	100.0**	0	0	2
Personal Care Facilities	50.0*	50.0*	0	0	1
Station Size	12.5	87.5**	0	0	1
Station Location	14.3	71.4*	14.3	0	2
Architectural Design	0	100.0**	0	0	1
Internal Environmental Standards	25.0*	62.5*	0	12.5	1
Final Design Selection	25.0*	50.0*	25.0*	0	1

** $\geq$ 70% responding

* $\geq$ 25% responding

Table 10. Statistics for Decisionmaking Responsibility
(Architects and Designers)

Design Component	% Indicating				Number not Responding or Invalid Response
	Transit Management	Designer Planner Architect	Local Government	Federal Government	
Handicapped Accommodations	14.3	42.9*	28.6*	14.3	4
Security Provisions	75.0**	16.7	8.3	0	6
Concessions	78.6**	21.4	0	0	4
Advertising	76.9**	23.1	0	0	5
Joint Development	46.2*	38.5*	7.7	7.7	5
Station Layout	0	100.0**	0	0	5
Personal Care Facilities	35.7*	64.3*	0	0	4
Station Size	7.7	92.3**	0	0	5
Station Location	8.3	75.0**	16.7	0	6
Architectural Design	0	100.0**	0	0	4
Internal Environmental Standards	15.4	76.9**	7.7	0	5
Final Design Selection	38.5*	46.2*	15.4	0	5

** $\geq$ 70% responding

* $\geq$ 25% responding

V. DECISION PRIORITIES IN DESIGN SPECIFICATION

The workshop participants rated the relative priority of several design elements in the total design process. The instructions for this item emphasized that priority should imply temporal ordering: higher priority items would be emphasized in the earliest stages of the design process, while lower priority items would be considered later. Each of sixteen (16) design elements was rated using a 10 point scale for which 1 = lowest priority and 10 = highest priority. Summary statistics for these ratings are given in Table 11. The mean ratings for the various design elements are plotted in order ot decreasing values in Figure 12. Station access, location of entry and exit points, and the number of passengers accommodated were perceived as having the highest priorities in the design process. Lower priorities were assigned to such elements as provisions for the handicapped and number of levels in the station.

Respondents could add to the list of elements provided: most additions concerned intermodal interfacing, and two dealt with passenger orientation and information. The ratings for these elements were very high, but since only those persons who felt the elements were extremely important listed them, the ratings may be biased and possibly nonrepresentative of the total sample.

Mean and median ratings of the priority of the design elements are shown in Figures 13 and 14 for the four groups of respondents. These groups generally agree in their ordering of the design elements. However, there are several items for which one occupational group rated the item as having higher priority than did the other three groups.

Statistical tests were done to detect relationships and interdependencies between ratings of different design elements. Intercorrelations of the priority ratings for all pairs of elements were computed, and the resulting matrix was subjected to a principal components analysis. [16] Three components were rotated to a varimax solution (Table 12). The loadings indicate how strongly each design element is related to the component. The components were interpreted as a passenger processing factor (I), entry/exit factor (II), and a configuration factor (III). Each of these components represents a cluster or combination of elements which seemed to "go together" in the ratings given by the respondents.

Table 11. Collective Statistics for Priorities of Design Elements

Variable	Rank	Mean	Median	Standard Deviation	Min	Max
Directional Information	10	7.548	7.938	2.230	2	10
Fare Collection	4	8.226	8.292	1.653	3	10
Location of Entry/Exit	2	8.512	8.654	1.256	5	10
Number of Entry/Exit	9	7.904	8.286	1.743	3	10
Number of Levels	15	6.614	6.778	2.191	2	10
Location of Joint Development	13	6.783	7.000	2.170	1	10
Location of Transit Area	7	8.037	8.135	1.585	3	10
Handicap Provisions	16	5.952	6.077	2.268	1	10
Quality of Internal Environment	14	6.774	7.214	1.891	1	10
Station Access Provisions	1	8.578	8.896	1.499	4	10
Entry Control	11	7.422	7.646	1.842	1	10
Control of Passenger Flow	6	8.048	8.190	1.707	4	10
Number of Passengers Accommodated	3	8.488	8.618	1.444	4	10
Level Change Aids	12	7.329	7.548	1.792	3	10
Security Provisions	8	7.988	8.382	1.929	3	10
Quality of Passenger Flow	5	8.131	8.395	1.706	3	10

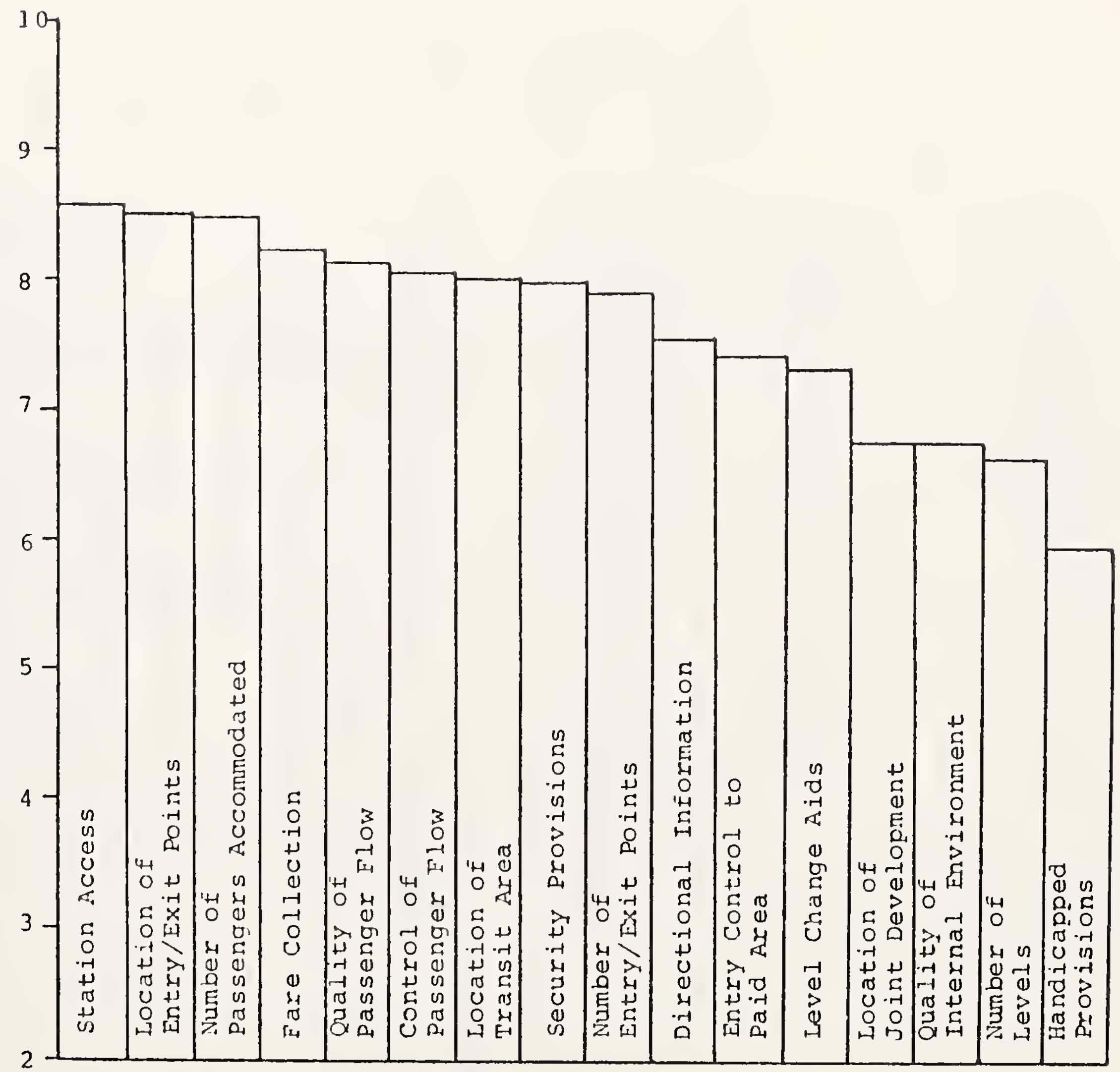

Figure 12. Mean Ratings of Design Priorities

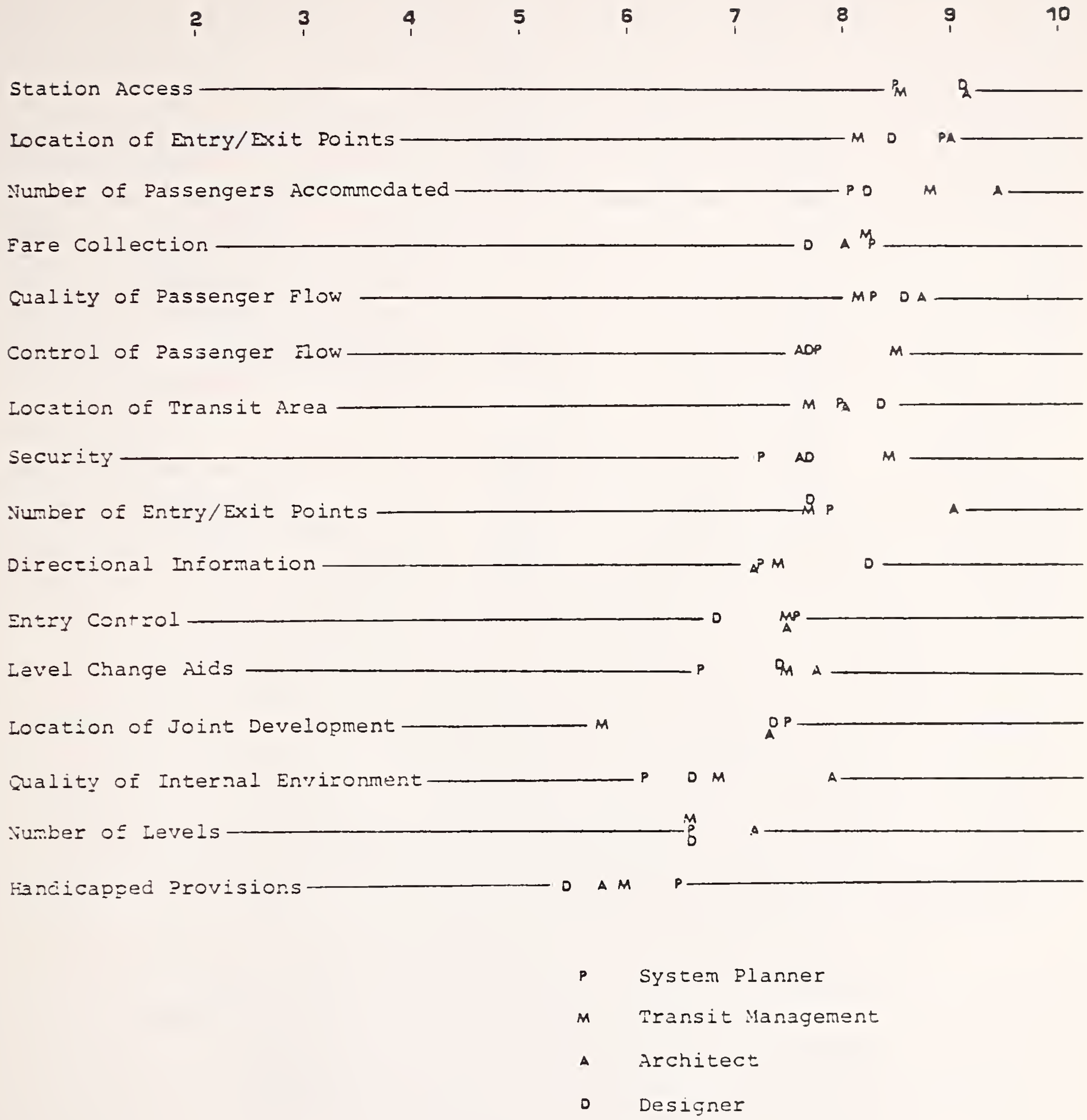

Figure 13. Mean Values of Design Priorities by Occupation

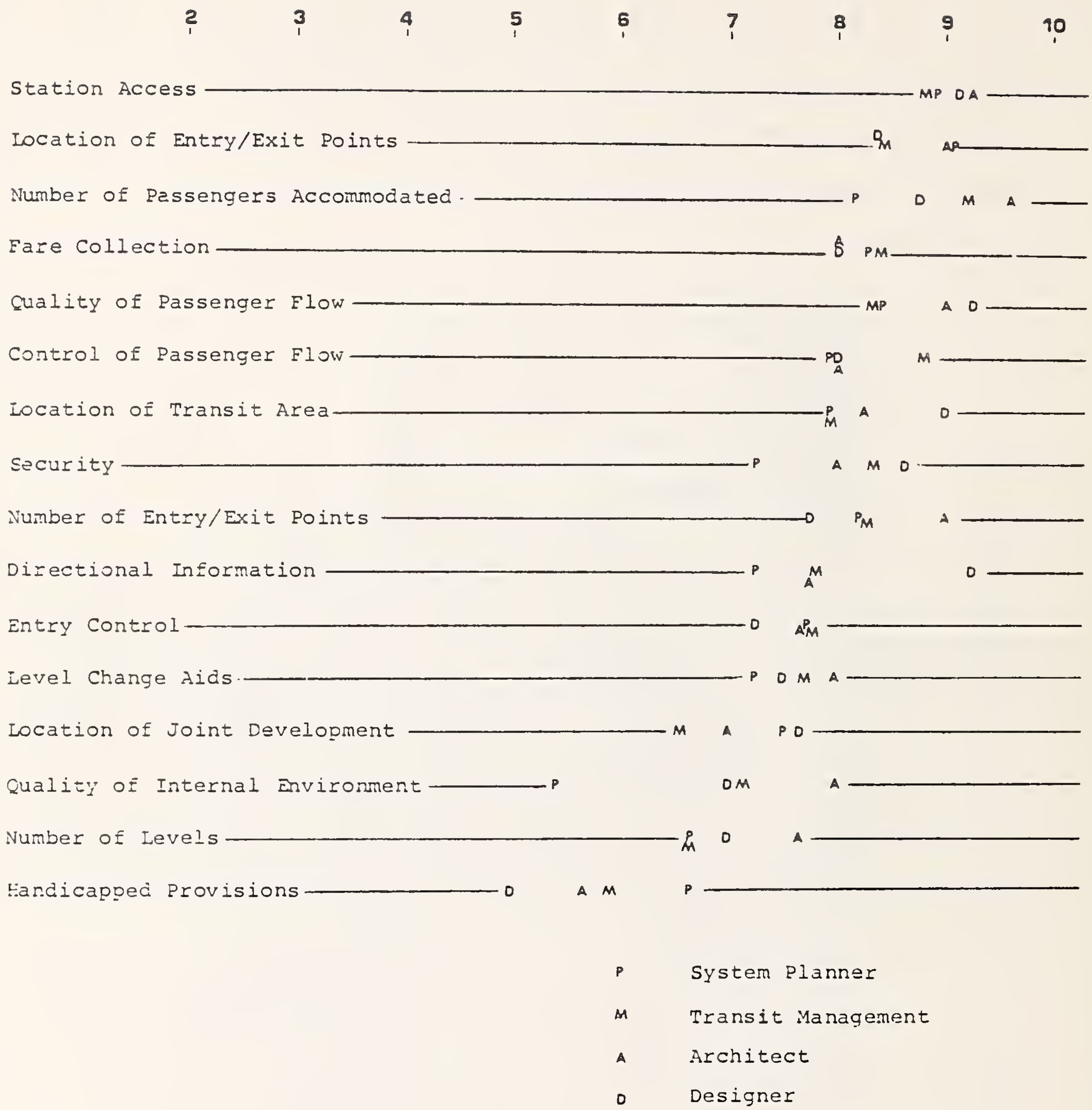

Figure 14. Median Values of Design Priorities By Occupation

Table 12. Loadings on Rotated Components

	PC 1	PC 2	PC 3
Directional Information	.74*	-.15	
Fare Collection	.51*	.26	-.17
Location of Entry/Exit		.78*	
Number of Entry/Exit		.79*	.20
Number of Levels		.54*	.31
Location of Joint Development		.27	.72*
Location of Transit		.23	.68*
Handicapped Accommodations	.31	-.17	.41
Quality of Internal Environment	.71*	-.21	.37
Station Access		.50*	.13
Entry Control	.52*	.50*	
Passenger Flow Control	.76*	.27	
Number of Passengers	.19	.56*	-.30
Quality of Passenger Flow	.62*		.40
Level Change Aids	.68*	.27	-.15
Security	.63*		.27

The mean ratings in Table 11 show the relative priority for the various elements as perceived by all of the respondents. It is also desireable to determine which of these mean ratings differ significantly from each other in a statistical sense. To determine this, t-tests were conducted between pairs of mean ratings of the design priorities. The results are shown in Figure 15. Three groups of elements were found; the elements within each group have mean ratings which do not differ significantly from those of others in the group. The groups of elements are separated by the lines in the figure. Elements in different groups have mean ratings which are significantly different. Division of this set of variables into significantly different groups ($p \leq .05$) was not very instructive because of the closely-bunched mean values.

APPLICATION

The priorities of the design elements are best presented as such; that is by priority. It is not necessary to present the magnitudes of priority if they are only to be used to indicate the order of consideration in the design process. This order of consideration is presented in Figure 16. The sixteen design elements are divided into three categories based on the pattern of statistical significance; the elements within each category do not have significantly different mean values ($p \leq 0.05$). They are, however, arranged vertically by mean value. For example, station access has a higher mean value than fare collection though the two are not significantly different.

For the planner, engineer, or designer, Figure 16 provides a reference indicating which design features or elements should be considered first, which second, and so on. The general category of passenger flow considerations (access, entry/exit, fare collection, and the control of quality of passenger flow) are considered the primary elements in designing a terminal facility. Likewise, items such as joint development, internal environment, and handicapped provisions constitute the elements to be considered late in the design process.

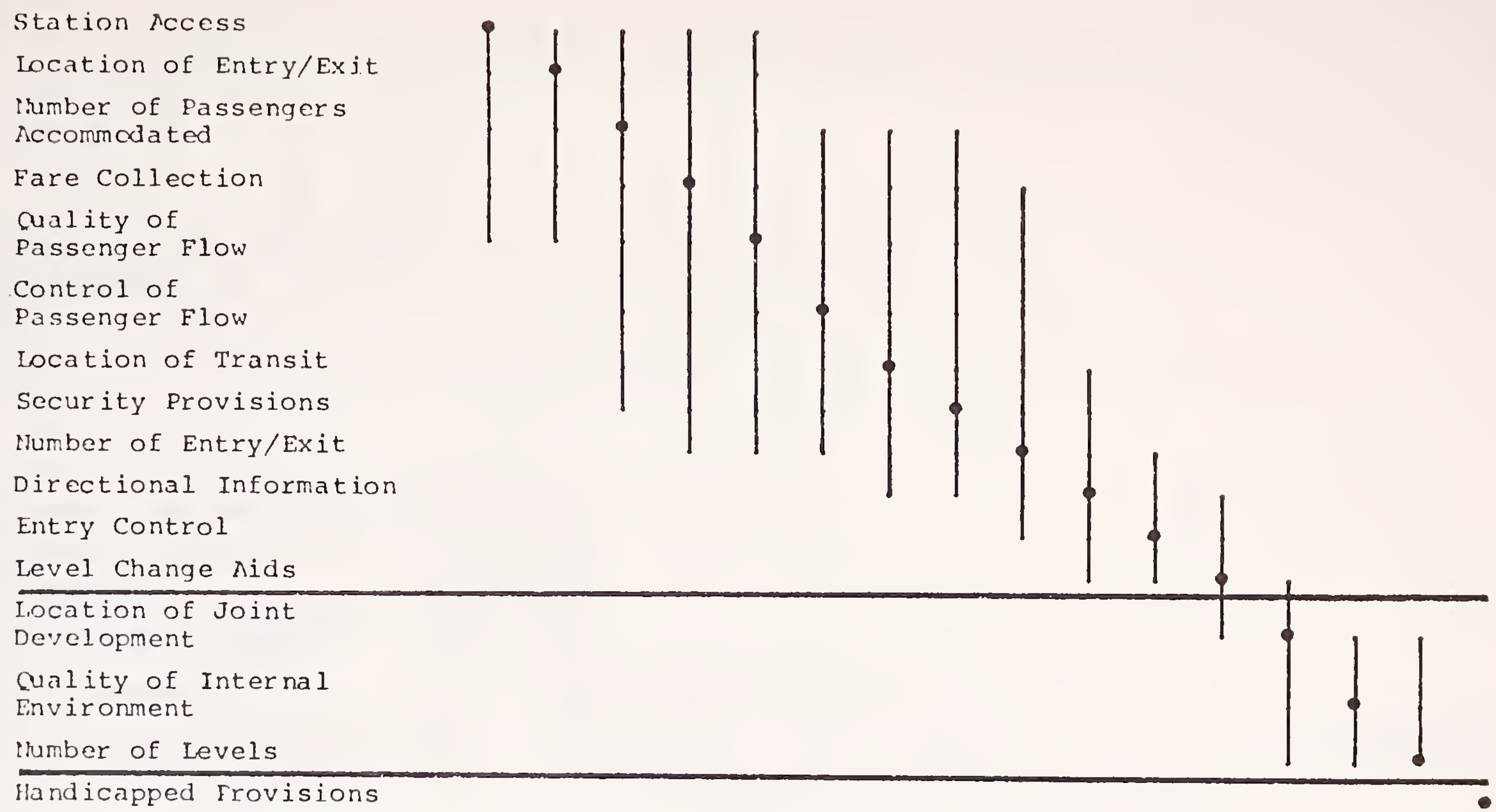

Figure 15. T-test Evaluation of Significant Differences Among Design Priorities

I

Station Access
Location of Entry/Exit
Number of Passengers Accommodated
Fare Collection
Quality of Passenger Flow
Control of Passenger Flow
Location of Transit Facilities
Security Provisions
Number of Entry/Exit
Directional Information
Entry Control
Level Change Aids

II

Location of Joint Development
Internal Environment Quality
Number of Levels

III

Handicapped Provisions

Decreasing Mean Value →

Decreasing Priority →

Figure 16. Prioritization of Design Element Considerations

VI. WEIGHTING OF CRITERIA IN DESIGN EVALUATION

Given a particular transit station design, how does a designer decide how "good" it is? Evaluation measures, or criteria, must be employed. By determining values on such measures, various station designs may be compared and the 'best' alternatives selected. However, in order to obtain a valid comparison of alternatives, it is necessary to know how important each of the criteria are to the overall evaluation. The respondents were asked to rate the relative importance of each of nineteen (19) design evaluation measures to the overall success of a design using a scale of one (1) to ten (10) where higher numbers indicate greater importance. Summary statistics for the resulting ratings are given in Table 13. The mean values are plotted in order of decreasing value in Figure 17. Mean ratings varied from 9.31 to 3.98, thus reflecting wide differences in perceived importance for the various measures. Most of the frequency distributions show substantial variability; the responses are spread over most of the possible categories. However, for four variables (efficiency of passenger movement, level of crowding, passenger safety, and passenger security), the distributions were highly skewed. In each of these cases, ten (10) was the dominant rating; indeed, for both safety and security, nearly 60% of the respondents gave an importance rating of 10.

From Figure 17, it can be seen that passenger safety and security as well as the efficiency of passenger movement and level of crowding are the measures perceived as having the greatest importance to the success of a particular station design. On the other hand, concessions and advertising were considered relatively unimportant.

Many respondents provided additional evaluation measures they felt were important but which had been omitted from the list. The proposed additions may be classified into 6 categories:

(1) Station access
(2) Passenger orientation
(3) Internal pedestrian circulation
(4) Traffic impacts of station location
(5) Cost
(6) Other

Table 13. Collective Statistics for Design Evaluation Measures

Variable	Rank	Mean	Median	Standard Deviation	Min	Max
Developmental Impacts	9	7.545	7.676	1.971	2	10
Environmental Impacts	10	7.295	7.630	1.919	3	10
Joint Development	12	7.059	7.200	2.200	2	10
Design Flexibility	5	7.864	8.079	1.931	3	10
Personal Care Facilities	17	4.920	5.040	2.081	1	10
Aesthetics	11	7.091	7.367	1.811	3	10
Advertising	19	3.977	3.643	2.176	1	10
Concessions	18	4.080	4.083	1.961	1	10
Number of Levels	16	5.593	5.395	2.555	1	10
Level Change Aids	6	7.773	8.150	2.099	1	10
Mechanical Backup Facilities	15	6.849	7.250	2.349	1	10
Energy Utilization	13	6.955	7.346	2.228	2	10
Level of Crowding	4	8.575	8.826	1.436	3	10
Efficiency of Passenger Movement	3	9.102	9.426	1.223	3	10
Passenger Safety	1	9.307	9.637	0.963	6	10
Passenger Security	2	9.207	9.630	1.173	4	10
Weather Exposure	7	7.761	7.933	1.590	4	10
Air Quality	14	6.830	7.147	2.102	1	10
Lighting	8	7.568	7.625	1.673	3	10

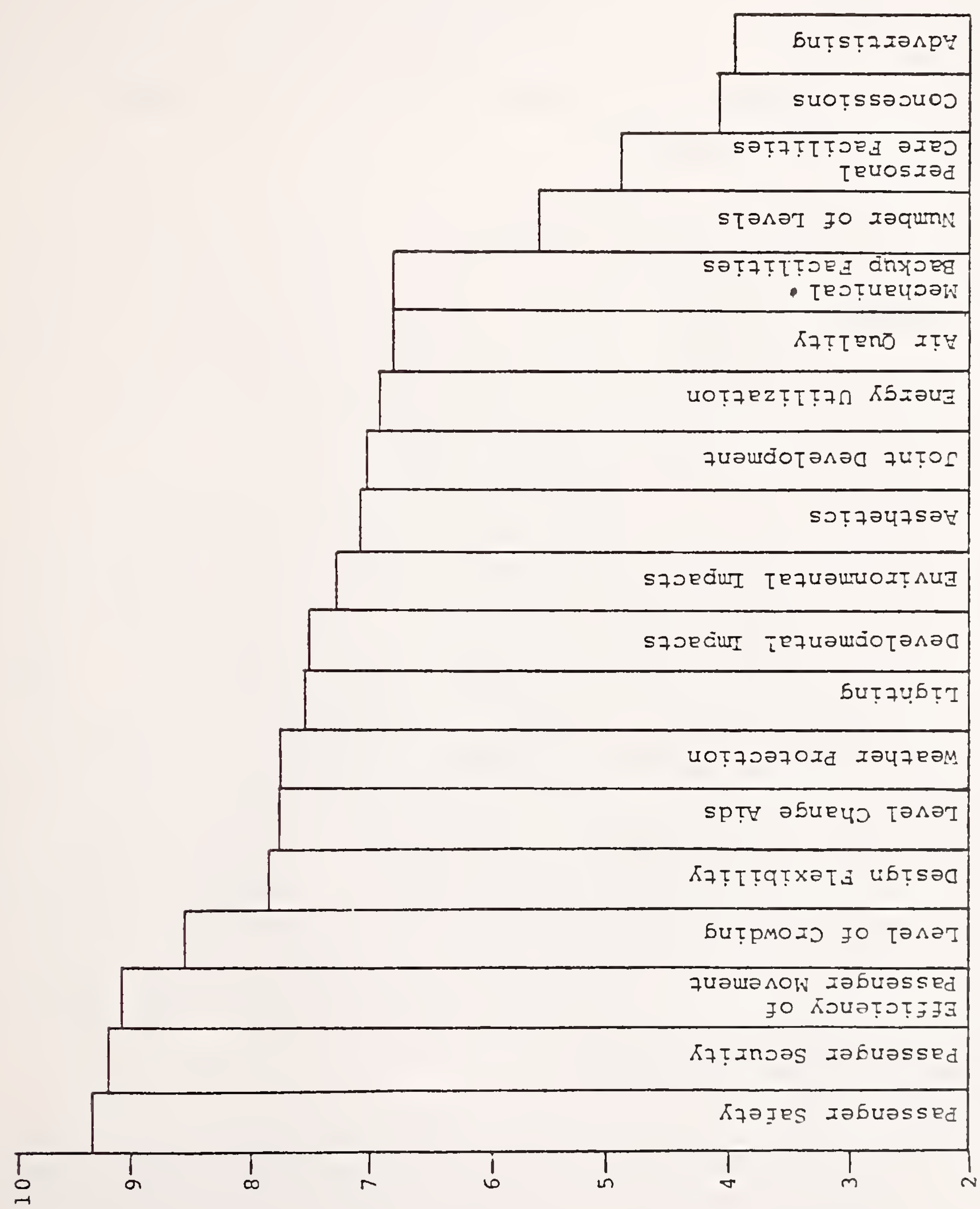

Figure 17. Mean Ratings of Design Evaluation Measures

Figure 18 shows the mean ratings of each measure for the various interest groups, while Figure 19 shows median ratings. There is a general agreement between the four occupatonal groups concerning the relative importance of the evaluation measures. Architects gave higher ratings for eight of the criteria than did members of the other groups, and these measures tended to be those in the middle range in terms of importance. Thus, architects felt that measures of developmental and environmental impacts, aesthetics, lighting, air quality, number of levels, and level change aids were more important in evaluating a station design than did respondents in the other groups. On many measures, planners tend to rate them of lesser importance, but this trend is less pronounced than that for the architects.

The correlation coefficients were computed between all pairs of measures. The correlation coefficient expresses the degree of linear relationship between the two variables in each pair. A principal components analysis was done on this correlation matrix. A five component solution was found appropriate. Hence, the first five principal components were rotated to a varimax solution. The loadings on these rotated components are shown in Table 14. Loadings whose absolute value exceeds .50 were used to identify each component. Component 1 is basically a passenger safety and security component. The loadings from air quality and energy utilization are somewhat anomalous, but they are less than those of the primary three variables. Component 2 seems to relate to pleasantness for people. Component 3 involves the amenities (personal care facilities, concessions, advertising, and aesthetics), some might call this a "frills" factor. Component 4 deals with level changes, and component 5 involves (external) system impacts. Thus, in the perceptions and judgments of these respondents, the 19 initial evaluation measures seem to reflect concerns with 5 basic factors of station design. Each of these factors or components represents a cluster or combination of measures which are related according to these respondents.

Several t-tests were performed on the mean values of the design evaluation measures. Using a significance level of .05, the reliable differences between means are shown in Figure 20. The ratings are listed in order of decreasing mean value. For each variable, the line running vertically from it to other variables and having a bullet next to the variable indicates those variables which are not signficantly different. For example, developmental

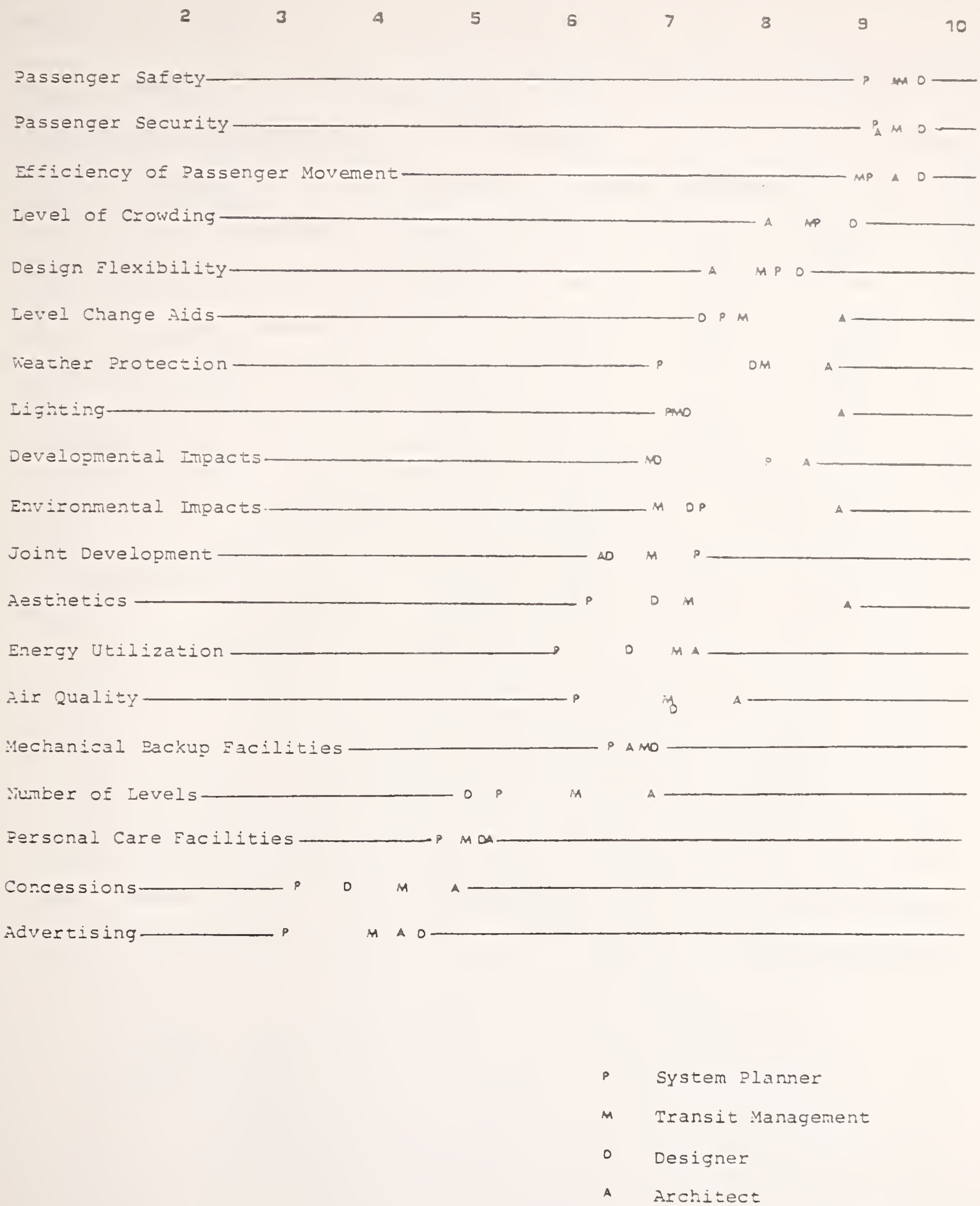

Figure 18. Mean Values of Design Evaluation Measures by Occupation

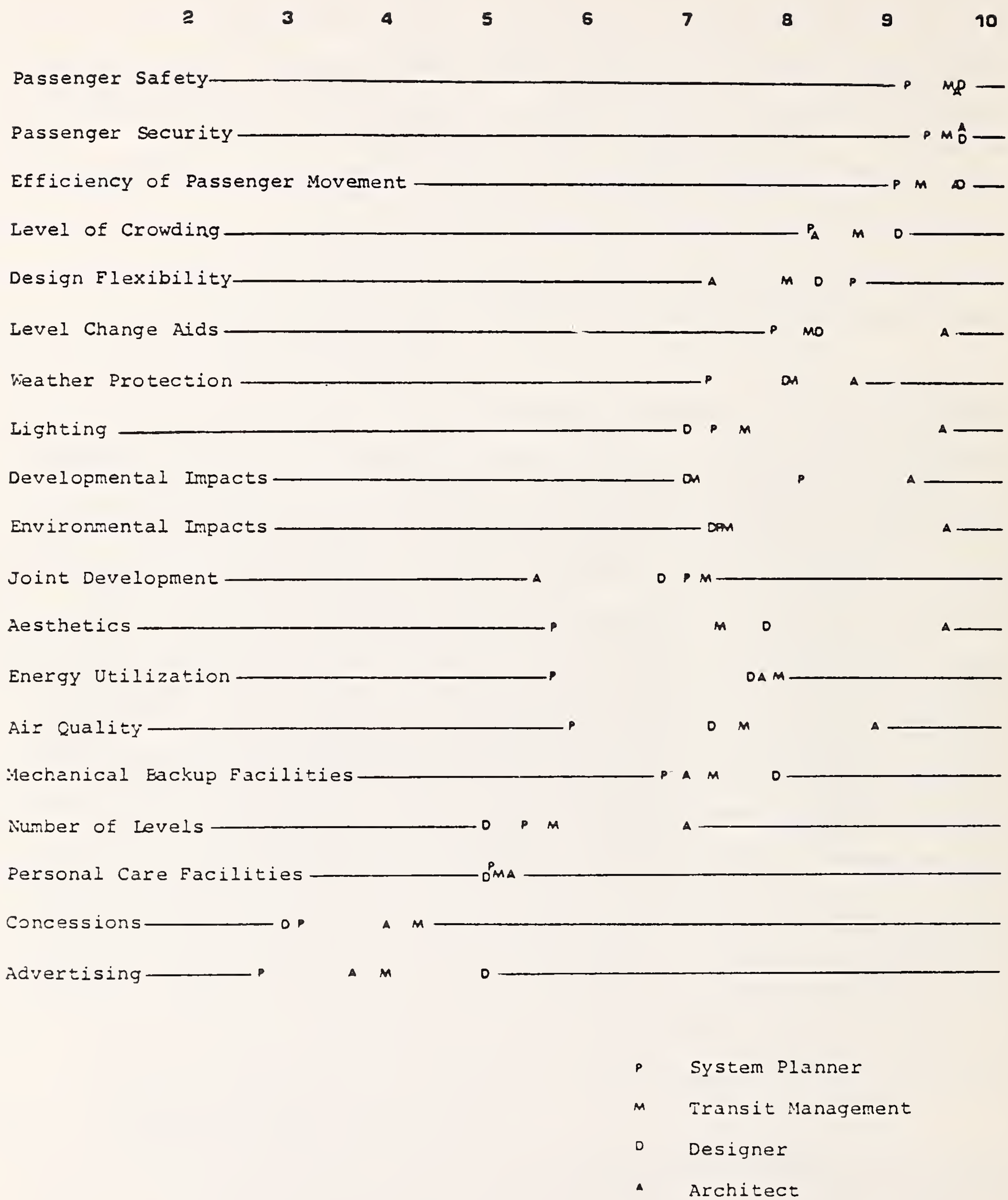

Figure 19. Median Values of Design Evaluation Measures By Occupation

Table 14. Loadings on Rotated Components

	PC 1	PC 2	PC 3	PC 4	PC 5
Developmental Impacts	-.14	.43	-.11		.71*
Environmental Impacts		.74*	.13		.43
Joint Development	.30		.20		.68
Design Flexibility					.59*
Personal Care Facilities	-.14	.28	.59*	.12	.24
Aesthetics	.14		.46*	.16	-.14
Advertising	.24		.71*		.13
Concessions			.78*		.19
Number of Levels		.14	.33	.65*	-.23
Level Change Aids	.24	-.11	-.11	84*	
Backup Facilities	.16	.13		.81*	
Energy Utilization	.53*	.23	.18	.30	.16
Crowding	.41	.59*	-.19	.16	
Passenger Movement	.19	.79*			-.18
Safety	.78*	.22		.19	
Security	.81*	-.13			.30
Weather Protection	.39	.19	.44	-.20	-.17
Air Quality	.52*	.59*	.19		
Lighting	.72*	.17	.22	.11	

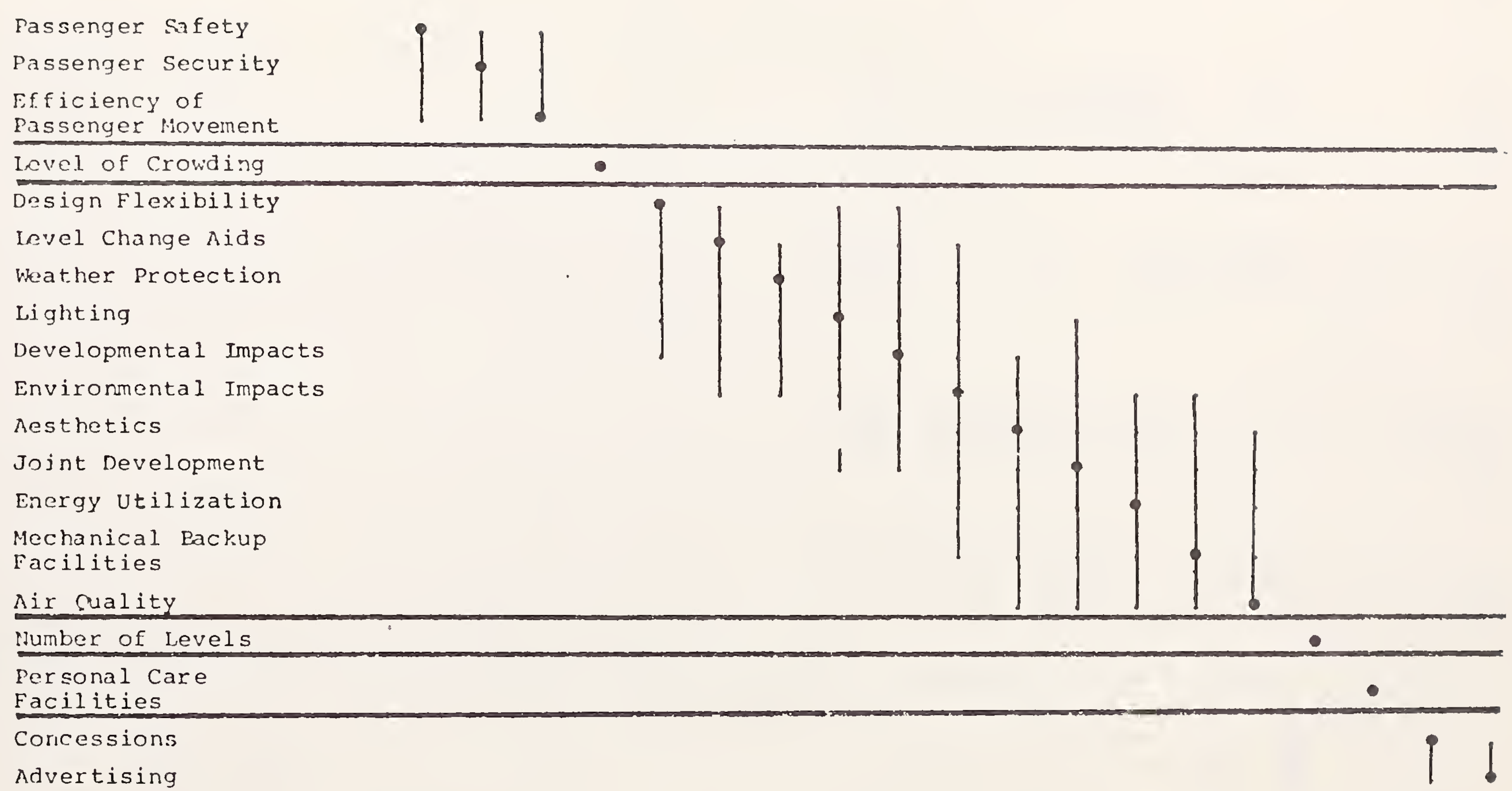

Figure 20. T-test Evaluation of Significant Differences Among Design Evaluation Measures

impacts is not significantly different from all of the variables between design flexibility and joint development. The heavier horizontal lines separate those variables into clusters such that the means within a group do not differ significantly from each other, while those in different groups do differ significantly.

APPLICATION

The responses obtained from questionnaires regarding the importance of particular elements to the overall success of a transit station design can be incorporated into an evaluation model. The basic requirements for such a model include measures of performance and utilities for each of the design elements to be included and the relative importance of each. According to Edwards (11), the technique of multiattribute utility measurement requires an appropriate aggregation rule and weighting procedure. Because of its simplicity and relative ease of use, the aggregation rule and weighting procedure incorporated in this report is a simple weighted linear average.

This report will estimate weights to be incorporated in the model of the form

$$U_i = \sum_j w_j u_{ij} \qquad (1)$$

where

U_i = total utility of alternative i,
w_j = weight attached to design element j, and
u_{ij} = performance of design element j in alternative i.

The weights, w_j, shall be developed from the solicited questionnaire responses. The development of performance measures, u_{ij}, was previously described by Demetsky and Hoel [8]. The particular measures need to be generated anew for each unique design application. Further research is necessary to determine the best method by which to evaluate the performance of both objective and subjective elements on a common scale (say, 0-100).

Thus, the weights can be developed as required from the mean values of the importance ratings (Table 15). Alternatively, the significance of the differences in mean values could be incorporated in determining the weights. Table 16 illustrates the separation of the design elements into statistically significant groups and the aggregate mean associated with each group. These aggregate means are simply the averages of the individual means within each group. The evaluation weights are then obtained for each combination as follows:

$$w_j = \frac{mean_j}{\sum_k mean_k} \tag{2}$$

where:

w_j = weight for each element in the combination j,

$mean_j$ = mean for combination j, and,

$\sum_k mean_k$ = sum of all combination means.

The calculated weights are presented in Table 17. Note that the sum of the weights taken over all the design elements is 100.

Thus the weights can be incorporated in the model

$$U_i = \sum_j w_j u_{ij} \tag{3}$$

along with the performance measures to arrive at a utility for each alternative design. Once the performance utility is established, tradeoffs may be made with costs to arrive at a final design.

Table 15. Mean Values of Design Evaluation Measures

Design Element	Mean
Passenger Safety	9.307
Passenger Security	9.207
Efficiency of Passenger Movement	9.102
Level of Crowding	8.575
Design Flexibility	7.864
Level Change Aids	7.773
Weather Protection	7.761
Lighting	7.568
Developmental Impacts	7.545
Environmental Impacts	7.295
Aesthetics	7.091
Joint Development	7.059
Energy Utilization	6.955
Mechanical Backup Facilities	6.849
Air Quality	6.830
Number of Levels	5.593
Personal Care Facilities	4.920
Concessions	4.080
Advertising	3.977

Table 16. Calculated Group Means for Design Evaluation Measures

Design Element	Mean	Group Mean
Passenger Safety	9.307	
Passenger Security	9.207	9.205
Efficiency of Passenger Movement	9.102	
Level of Crowding	8.575	8.575
Design Flexibility	7.864	
Level Change Aids	7.773	
Weather Protection	7.761	
Lighting	7.568	
Developmental Impacts	7.545	7.326
Environmental Impacts	7.295	
Aesthetics	7.091	
Joint Development	7.059	
Energy Utilization	6.955	
Mechanical Backup Facilities	6.849	
Air Quality	6.830	
Number of Levels	5.593	5.593
Personal Care Facilities	4.920	4.920
Concessions	4.080	4.029
Advertising	3.977	

Table 17. Calculated Weights Associated With Design Evaluation Measure Groups

Design Element	Mean	Group Mean	Weight
Passenger Safety	9.307		6.8
Passenger Security	9.207	9.205	6.8
Efficiency of Passenger Movement	9.102		6.8
Level of Crowding	8.575	8.575	6.3
Design Flexibility	7.864		5.4
Level Change Aids	7.773		5.4
Weather Protection	7.761		5.4
Lighting	7.568		5.4
Developmental Impacts	7.545	7.326	5.4
Environmental Impacts	7.295		5.4
Aesthetics	7.091		5.4
Joint Development	7.059		5.4
Energy Utilization	6.955		5.4
Mechanical Backup Facilities	6.849		5.4
Air Quality	6.830		5.4
Number of Levels	5.593	5.593	4.1
Personal Care Facilities	4.920	4.920	3.6
Concessions	4.080	4.029	3.0
Advertising	3.977		3.0

VII. SUMMARY

Two preliminary decision procedures have been discussed in this report: a sequential decision model for transit station design and a multiattribute linear model of design evaluation. Data related to aspects of those models were gathered from participants at a National Conference on Transit Station Design. Nearly a hundred attendees responded to a questionnaire distributed at the conference. These respondents indicated who they thought should have primary responsibility for various design decisions, judged the priorities of selected decisions in the overall design process, and rated the importance of several criteria in evaluating the success of a station design.

There was general agreement among the respondents that decisions concerning security, concessions and advertizing should be made by transit management. Station layout and architectural design were viewed as the domain of the designer/architect/planner. Joint development, station location and provisions for the handicapped were attributed about equally often to each of three interest groups (management, designers, and local government), and thus joint decisionmaking responsibility is indicated here. The final design selection is the responsibility of management. These respondents saw little role for the federal government in the transit station design process.

Respondents rated the priority in the overall design process of several design elements. The instructions for this task specified that priority implies temporal ordering: high priority elements would be considered first, low priority items last. Station access, location of entry and exit points, number of passengers accomodated, fare collection, and the characteristics of passenger flow were assigned the highest priorities in the design process.

The importance of various criteria to the success or evaluation of a station design was also indicated by these respondents. Passenger safety and security, efficiency of passenger movement, and level of crowding were rated the most important; concessions and advertizing were the least important.

The results of this survey clearly reflect the perspective of the planner/designer and the transit manager/operator. Those are the people who attended this conference. Other actors in the public policy arena are not represented here. Thus, local government officials, business concerns, and public action groups were not sampled because they did not attend the conference. These other actors may influence both policy and design in various ways. Thus a higher order decision model is necessary to reflect public policy and decision making at the community level. Such a model would require specification of the mechanisms of influence, compromise, and conflict resolution. Clearly, the values of people in these other interest groups might differ from those of the designer. But, our interest here was specifically in the values and perceptions of those people who are actively involved in terminal design. Models of community decision processes are left for future research.

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APPENDIX A

QUESTIONNAIRE

TRANSIT STATION DESIGN SURVEY

Douglas M. McCants
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Department of Civil Engineering
University of Virginia

As part of a continuing effort to improve and update the station design research at the University of Virginia, we would appreciate you taking the time to complete the following questionnaire. This survey will provide feedback on and evaluation of the UVA reports, and gather some new data necessary for our understanding of the station design process.

Background Information

What is your current job title? ______________________________

How long have you performed work similar to your current job? ______ yrs

Please check those areas in which you received your formal education (training).

- Mechanical Engineering ☐
- Civil Engineering ☐
- Finance ☐
- Business ☐
- City Planning ☐
- Architecture ☐

Other: ____________________

How would you classify your current position?

- System Planner ☐
- Architect ☐
- Management ☐
- Design ☐
- Operations ☐
- Political ☐
- Maintenance ☐

Other: ____________________

Have you been directly involved in the planning and design of transit stations?

- Yes ☐
- No ☐

If so, For how long? ______ yrs

What type of system(s)?

Light Rail Transit ☐
Urban Rapid Rail ☐
Regional Rail ☐
Bus ☐

Other: ____________________

List the cities whose systems you have worked on.

____

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Critique of the Design Methodology

Have you read the publications describing the University of Virginia station design methodology?

Yes ☐
No ☐

Did you find each of the following publications valuable?

	Yes	No	No Opinion
Methodology for Design	☐	☐	☐
Criteria	☐	☐	☐
Procedural Guide	☐	☐	☐
Renovation Case Study	☐	☐	☐
Security Planning	☐	☐	☐

Who do you feel would benefit from these publications (e.g., planner, architect, engineer, etc.)?

Methodology for Design ____________________

Criteria ____________________

Procedural Guide ____________________

Renovation Case Study ____________________

Security Planning ____________________

How do you think the design methodology as presented in the foregoing publications can be improved?

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Decisionmaking

For each of the station design components listed below, who do you feel should be primarily responsible for the decisions regarding it?

Component	Transit Management	Designer Planner Architect	Goverment Local	Goverment Federal
Handicapped Accommodations	☐	☐	☐	☐
Security Provisions	☐	☐	☐	☐
Concessions	☐	☐	☐	☐
Advertising	☐	☐	☐	☐
Joint Development	☐	☐	☐	☐
Station Layout	☐	☐	☐	☐
Personal Care Facilities	☐	☐	☐	☐
Station Size	☐	☐	☐	☐
Station Location	☐	☐	☐	☐
Architectural Design	☐	☐	☐	☐
Internal Environmental Standards	☐	☐	☐	☐
Final Design Selection	☐	☐	☐	☐

Design Evaluation Measures

The items listed below comprise the criteria or evaluation measures as developed in the University of Virginia station design methodology. Indicate on a scale of one (1) to ten (10) how important you feel each is in determining the success of a particular station design. A score of one (1) would indicate that an item is of no importance to the design evaluation; a score of ten (10) would indicate that an item is of major importance. Please feel free to add to the list of measures as you feel necessary. After completing all of your ratings, please review them to see if there are any you would change. If so, feel free to change them.

Measure	Circle One Number for Each Measure (1=no importance; 10=major importance)									
Developmental Impacts on the Surrounding Area	1	2	3	4	5	6	7	8	9	10
Environmental Impacts on the Surrounding Area	1	2	3	4	5	6	7	8	9	10
Joint Development	1	2	3	4	5	6	7	8	9	10
Design Flexibility (for future expansion or change)	1	2	3	4	5	6	7	8	9	10
Personal Care Facilities	1	2	3	4	5	6	7	8	9	10
Aesthetics	1	2	3	4	5	6	7	8	9	10
Advertising	1	2	3	4	5	6	7	8	9	10
Concessions	1	2	3	4	5	6	7	8	9	10
Number of Levels	1	2	3	4	5	6	7	8	9	10
Level Change Aids (Elevators, Escalators, etc.)	1	2	3	4	5	6	7	8	9	10
Backup Facilities for Level Change Aids	1	2	3	4	5	6	7	8	9	10
Energy Utilization	1	2	3	4	5	6	7	8	9	10
Level of Crowding in Station	1	2	3	4	5	6	7	8	9	10
Efficiency of In-station Passenger Movement	1	2	3	4	5	6	7	8	9	10
Passenger Safety	1	2	3	4	5	6	7	8	9	10
Passenger Security	1	2	3	4	5	6	7	8	9	10
Protection from Weather	1	2	3	4	5	6	7	8	9	10
Air Quality	1	2	3	4	5	6	7	8	9	10
Lighting	1	2	3	4	5	6	7	8	9	10
____________________	1	2	3	4	5	6	7	8	9	10
____________________	1	2	3	4	5	6	7	8	9	10
____________________	1	2	3	4	5	6	7	8	9	10

Design Priorities

Listed below are the major elements in the station design process as developed by the University of Virginia. For each, indicate on a scale of one (1) to ten (10) its relative priority or importance in the design process. A score of one (1) would indicate that an item is of the lowest priority; a score of ten (10) would indicate that it is of the highest priority. In general, higher priority items would be emphasized at the earliest stages of the design process; lower priority items would be considered later. Decisions made early may dictate constraints on later design decisions. Please feel free to add to the list of elements as you feel necessary.

Element	Circle One Number for Each Element (1=lowest priority; 10=highest priority)									
Directional Information	1	2	3	4	5	6	7	8	9	10
Fare Collection	1	2	3	4	5	6	7	8	9	10
Location of Entry/Exit Points	1	2	3	4	5	6	7	8	9	10
Number of Entry/Exit Points	1	2	3	4	5	6	7	8	9	10
Number of Levels	1	2	3	4	5	6	7	8	9	10
Location of Joint Development (within station facility)	1	2	3	4	5	6	7	8	9	10
Location of Transit Area (within station facility)	1	2	3	4	5	6	7	8	9	10
Handicapped Provisions	1	2	3	4	5	6	7	8	9	10
Quality of Internal Environment	1	2	3	4	5	6	7	8	9	10
Station Access Provisions	1	2	3	4	5	6	7	8	9	10
Entry Control to Paid Area	1	2	3	4	5	6	7	8	9	10
Control of Passenger Flow	1	2	3	4	5	6	7	8	9	10
Number of Passengers Accommodated	1	2	3	4	5	6	7	8	9	10
Quality of Passenger Flow	1	2	3	4	5	6	7	8	9	10
Level Change Aids	1	2	3	4	5	6	7	8	9	10
Security Provisions	1	2	3	4	5	6	7	8	9	10
____________	1	2	3	4	5	6	7	8	9	10
____________	1	2	3	4	5	6	7	8	9	10
____________	1	2	3	4	5	6	7	8	9	10

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