U.S. ARMY

Technical Note 9-68

SYSTEM ANALYSIS: MANPOWER RESOURCES/ SYSTEM DESIGN INTEGRATION METHODOLOGY

John D. Weisz

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HUMAN ENGINEERING LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

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ABSTRACT

General methodology is introduced which, when used appropriately by decision makers, may assist them in deciding which system concept among several to approve for further development purposes. Trade-off aspects of system analyses studies are also discussed.

SYSTEM ANALYSIS: MANPOWER RESOURCES/

SYSTEM DESIGN INTEGRATION METHODOLOGY

In a previous U. S. Army Human Engineering Laboratories (HEL) report (3), Weisz discussed human factors research and development contributions to System Analysis. Block 33 of the new "Disciplined Management Model for the Department of the Army" calls for the "Combat Developer" to perform trade-off analyses "to assure that the configuration of a system represents the best balance among cost, schedules, human factors and operational effectiveness." If alternate technical approaches are being proposed to meet a particular materiel requirement (QMR), technical and economic evaluations obviously have to be made in order to select the best solutions to meet the requirement within the restrictions (time, cost, etc.) imposed.

Manpower, and the integration of all manpower factors into materiel development programs, have recently been high-lighted in a Department of Defense study (1). Manpower factors here include such aspects as skill levels, proficiency, availability, rotation rates, costs, etc., necessary to the evaluation of alternative designs with a view to determining the optimum design for minimum cost of ownership and maximum effectiveness.

A new Army Regulation (2) lists as one of its main objectives, "to improve control of total life cycle costs of man-materiel systems by assuring consideration, early in the materiel life cycle, of the cost of manpower resources and training for alternative systems." This regulation also points out that this new envisioned Army program includes "that part of system analysis that determines man's role in a man-materiel system."

If, as has been clearly indicated above, it is now the policy of Department of Defense and Department of Army to take manpower factors into consideration in system analyses studies, how should this be accomplished? This Technical Note, then, attempts to establish a general framework around which manpower factors can be effectively introduced into system analyses studies.

Let us assume that as a result of having an approved QMR the developer has either developed internally or received several proposed system concepts to meet the requirement. With expert inputs from specialists in training, selection and utilization of personnel, and human performance, a human factors team should be able to provide decision makers with an estimate of which concept from the human factors viewpoint will better fulfill the system performance requirements stated in the QMR at the least total cost to the Army. This estimate, quantitatively stated.

should then be included along with the other important areas which comprise the various facets of the system analysis. To illustrate the procedures further here let us agree that, when considered with all other factors included in the system analysis, the total manpower factors component will have a weighting of 25 percent of the total 100 percent. Within the manpower factors component a further breakout may be established for purposes of discussion:

a. Trainability: Expressed in terms of feasibility, or time and cost of training operators and/or maintenance personnel or of retreading existing Army personnel specialities:	5%
b. Skill Requirements: When considered along with personnel skills available to the Army for the time frame within which the proposed system is to become operational:	5
c. Level and complexity of human performance required: In terms of accuracies required to perform critical tasks of system operation, keeping in mind the battlefield environment:	15
	25%

To successfully conduct the manpower factors part of the system analysis study, the Army must have available a constantly updated data bank in the manpower resources area. The data bank would contain training time and cost data on all past fielded systems, the skill-level breakout of the present Army as well as that predicted for the future, and performance data on man's capabilities and limitations in the areas of vision, audition, taste, smell, tactile sense, psychomotor performance, behavioral reactions, biomedical factors, etc. (Note: A good beginning in the latter area has been underway for a number of years, resulting in a repository of information established under Army sponsorship.)

Experts in the areas of training and job analysis should be able to estimate the training and the skills required for the successful operation and maintenance for each concept being considered in the evaluation, and to utilize the data bank information to arrive at time and cost data for inclusion in their areas of specialization (a and b above). If the estimates are detailed enough, sufficient sensitivity should exist to differentiate between the two concepts being considered. Thus one system, as far as either of these two areas are concerned, would be preferable to the other.

Having appropriate data in the data bank on the performance aspects should largely determine the ease with which one could arrive at applicable comparative estimates of men's performance within either of the proposed concepts. If data is not readily available, human performance experts can, at least, make probability estimates that man can or cannot perform the functions required of him in each concept. If, for instance, one concept requires the operator to make accurate

visual range estimates whereas the other concept requires only range approximation, i.e., having a range-gating capability, since we know the approximate error of man making range estimates with the naked eye, one would rate the potential of the latter concept considerably higher than the former.

A composite rating of the various manpower resources sub-categories (training, personnel skill utilization, and performance) would then be used to compare concepts, with the one having the highest rating obviously being the one recommended for further development, for source-selection purposes or system feasibility-study purposes.

Following the initial system-concept comparison as described above, it may well be that decision makers would want trade-off studies conducted. It is very likely that, as in the example above, a range-gating capability might give a higher probability of first-round hits since the range estimates would be more accurate, but, on the other hand, such a capability would probably require frequent calibration and/or more maintenance and thus require more personnel time and possibly a more highly or differently skilled individual in each crew. Again, the human factors team could assist in deriving appropriate trade-off data in various forms: cost, estimated amount of down time, system performance change, and personnel skill-requirements changes.

Even as the human factors team could show trade-off results between the sub-components of the manpower factors component, so also could total-system analysts perform trade-offs between the major areas contributing to the system analysis study until some optimum combination of all areas is achieved. The optimum combination is obviously applicable only for the time being and only under the restrictions imposed (cost, available manpower, development time, threat, etc.). As was pointed out in the DoD Manpower Study (1), we can no longer afford to develop equipment and merely hope that the necessary manpower can be found to man it and/or trained to man it in a relatively short time. Cost of training and, especially, time available for such training on a mass basis may not permit such selection and training under wartime conditions.

In summary, although a detailed model needs yet to be developed, present procedures permit us to participate in comparative analyses of various materiel concepts from the human factors point of view. More sophisticated procedures are needed to fully exploit this aspect in the materiel development decision-making process.

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3. Weisz, J. D. System analysis: Human factors research and development contributions. Technical Note 7-67, U. S. Army Human Engineering Laboratories, Aberdeen Proving Ground, Md., 1967.

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* U. S. Army Human Engineering Laboratories Aberdeen Proving Ground, Maryland 21005	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

SYSTEM ANALYSIS: MANPOWER RESOURCES/SYSTEM DESIGN INTEGRATION METHODOLOGY

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

John D. Weisz

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
August 1968	9	3

8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Technical Note 9-68 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

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DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Human Factors Field System Analysis Man Component						