# *Personality Correlates To Performance Under Stress In Simulated Chemical Plant Emergencies*

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# PERSONALITY CORRELATES TO PERFORMANCE UNDER STRESS IN SIMULATED CHEMICAL PLANT EMERGENCIES

Submitted in partial fulfilment of the requirements for the degree of Master of Arts of the Department for Psychology at the University of Natal, Durban.

HANS PETER LEHMANN
DURBAN/SASOLBURG 1978

DECLARATION.

I declare this thesis, except where otherwise indicated in the text and acknowledgements, to be my own original work.

H.P. LEHMANN

CONTENTS

## 1. ACKNOWLEDGEMENTS

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## 2. AIM OF THE RESEARCH

When a fault develops in a chemical plant process, the plant operator must identify the fault rapidly and take immediate corrective action.

The interaction of process factors varies from fairly to highly complex (in extreme cases, this interaction is not yet fully understood even by chemical engineers) and consequences of faults can occur in chainreactions.

The operators task is to control all process parameters until the plant is brought back to normal conditions. Doing this, he is fully aware of the fact, that the consequences of wrong corrective action or failure to bring the plant under control can be grave in economic terms, extremely serious (lethal) in terms of the operator's hazards and potentially catastrophic.

Thus a considerable amount of stress can be built up, which is potentially interfering with the "cool" required to succeed in overcoming the emergency as quickly and efficiently as possible.

This project attempts to explore presumed correlations between personality factors and performance under stress.

Where such correlations exist in significant manifestation, their rank of magnitude was established and their predicitive value investigated.

## 3. PERSONALITY FACTORS AND COPING IN STRESSFUL SITUATIONS: A BRIEF REVIEW WITH PARTICULAR REFERENCE TO THIS INVESTIGATION.

In LAZARUS' model of coping with stress (Lazarus 1966) he found that personality factors influence the appraisal of threat as well as determining the coping process and the secondary appraisal of threat. He states:

> "Three main classes of factors in the individual psychological structure influence threat appraisal. They do so by providing the capacity and dispositional bases for interpreting the significance of the stimulus cues.
>
> The three classes are:
>
> 1 motivational characteristics of the individual;
>
> 2 belief systems concerning transactions with the environment;
>
> 3 intellectual resources, education, and sophistication".

These personality factors shape the inferences the individual can and will make about the stimulus configuration.

In discussing and specifying these three categories LAZARUS summarises that

> 1 The pattern and the strength of the motivation determines stress reactions. Situations will be appraised as threatening to the extent that they communicate with important goals;
>
> 2 Belief systems that deal with the confrontation of threat, e.g. beliefs that the environment was hostile and dangerous, could shape threat appraisal in any situation.

He argues that such general beliefs about the environment and one's ability to deal with it probably underlie (chro~ic) anxiety, and that thus anxiety is the original dispositional trait, if interpreted as the disposition to be threatened in a wide (or narrow) variety of situations;

2 Intellectual resources play an important part in influencing threat appraisal, but they are nondirectional with respect to whether they yield greater or less threat.

The conclusion is drawn that although the influence is non-directional, it does appear that lack of sophistication should increase the prospects of incorrect evaluations of the situation.

How personality traits may affect coping with stress can be divided into three main categories. LAZARUS states:

> "The factors within the psychological structure that we shall discuss as influencing coping include some which do so by affecting secondary appraisal, some which do so directly because they refer to capacities, and some which are treated as dispositional variables which are neutral with respect to this issue of how they work.
>
> We shall consider four classes of factors within the psychological structure that influence coping:
>
> 1 pattern of motivation,
> 2 ego resources,
> 3 defensive dispositions,
> 4 general beliefs about the environment and one's resources."

These four classes can be summarized with respect to the direction of influence as follows:

- Motivation determines which kind of action poses additional threat via a psycho-economic decision within the secondary appraisal and therefore influences the coping process indirectly.

- Certain ego resources, especially the capacity for impulse control and ego strength, influence coping directly rather than via appraisal.

- Those defensive dispositions (i.e. personality traits comprising the tendency to use one or another type of defense when the individual is threatened) that influence the reaction to threat in a particular way, are:

  - tendency to cope or avoid
  - the trait of "defensiveness" (tendency to deny weakness in oneself)
  - perceptual defence tendencies (e.g. sensitisation vs. repression)
  - consistency and/or generality of defence

- Beliefs about one's resources influence the individual's choice how to cope via secondary appraisal. LAZARUS however emphasises that this cognitive determination does not imply that the coping process is conscious, rational, or adaptive; any irrationality does not come from the interposition of emotion in thought, but is a reflection of the particular cognitive structure of the individual which disposes him to interpret situations in particular ways.

LAZARUS' theorem of interaction between personality factors and the coping process may be summarized as follows:

| CLASSES OF FACTORS | INFLUENCE ON STRESS REACTION |
|---|---|
| 1. <u>Motivation</u> | |
| Motivation pattern | primary threat appraisal |
| Motive strength | determines coping via secondary appraisal |
| 1 <u>Personality traits</u> | |
| Anxiety (as the disposition to be threatened by situations consequential to and/or implied by belief systems concerning transactions with the environment) | primary threat appraisal |
| Defense dispositions | coping process via secondary threat appraisal |
| Ego resources | coping process and coping strategy |
| 2 <u>Cognitive belief systems</u> | |
| These include the cognitive aspects of such belief systems that underlie anxiety and general beliefs about aspects of the environment (irrespective of their rationality) and concerning one's ability. | coping process via secondary threat appraisal. |
| 4 <u>Intellectual resources</u> | |
| (intelligence and sophistication) | primary and secondary threat appraisal, non-directional to the process. |

Research since then (1966) seems to have accepted this theorem in general.

The research activities in relation to derivatives and components of the overall theory can be divided into two principle parts, according to the breadth of approach.

Two selected studies which are of relevance to this investigation may be taken as examples of the broader approach, i.e. where it was attempted to establish connections between a battery of personality factors, several stress reactions and a variety of performance criteria, and the aim was the establishment of syndromes with respect to predictive quality rather than an in-depth exploration of the interaction of single variables.

JENNINGS, KREUZ & ROSE (1974) related military performance to measures of personality and stress. The design they used was a parallel one, i.e. personality measures and stress measures were equally and unilaterally valued as one-dimensional variables for the prediction of performance as the dependent variable. Ss were 69 candidates of an Officer Candidate School (OCS). The hypothesis put under test was that certain personality factors and styles of coping with stress should be predictor variables for the performance of candidates/officers during and after OCS.

Their findings distinguished between performance as officers (after graduation from OCS) and performance during the course (expressed as class-standing). Certain personality-factors and "maturational" variables seemed to correlate favourable with performance as officers, while no relation was found between coping with stress and the performance on duty as officers.

The data presented indicates that there may be a cross-correlation between personality traits, the occurrence of stress during the OCS and later officer-performance.

(The correlation-coefficients found, however, were so small and mostly insignificant, that, in a strict statistical sence, no conclusion whatsoever should have been drawn).

The second study, that uses a similar approach, is the investigation of J. DANIELS (1973) about personality traits and the adaption to "psychological" stress. *)

DANIELS supposes that previous research has implied that through the adaption to stress conditions, certain psychological and physiological indicators in the individual's stress reaction show a tendency to change and then differ from those observed under short-term stress. The objective of his study was to examine how and if personality traits, which are considered to be relatively stable, become altered under the effect of adaption to longer-term stress-conditions. Scores for personality traits (measured by the 16PF) were obtained from 85 parachutists, 40 experienced and 45 novice (first-time) jumpers.

DANIELS found that experienced parachutists showed higher scores in Factor A (Affectothymia), in Factor B (Scholastic Mental Ability) in Factor C (Ego Strength), in Factor E (Dominance) in Factor G (Superego Strength), in Factor Q1 (Radicalism) and in Factor Q2 (Self-sufficiency).

Expressing these findings in Cattells second and third stratum factors (Cattell et al. 1970), this means that experienced jumpers are higher on "Strength" (3rd-stratum factor), lower on "Anxiety" (2nd - stratum factor) and higher on "Independence" (2nd stratum factor).

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*) = Adopting the distinction between psychological and physiological stress after Lamb (1976), as mentioned below, one would rather classify the stress experienced in parachute jumping as physiological.

From data presented however, it is not conclusive that these differences are in any correlation to any adaption to stress that may be present in experienced parachutists. What is shown is that experienced parachutists differ in certain personality traits from individuals who try parachute jumping for the first time. It is equally likely that there is a selection process: only individuals with the configuration of personality traits conducive to endure stress, as shown by Daniel, become experienced parachute jumpers, the remaining proportion of novices drop out due to lack of sufficient coping "ability". *)

However, for the question, which set of personality traits correlates favourably with criteria for performance under stress, the establishment of significant differences in personality factors is sufficient. It may only be noted here, that DANIEL's results do conform with other findings in this field.

Where recent research work has concentrated more on the exploration of specific personality traits and their connection with stress and the coping process, an increasing emphasis was put on distinguishing between transitory emotional states and relatively stable personality traits, the latter regarded as primary, or basic, dispositions of the individual. Of particular interest, especially regarding the subject of this investigation was the development of a state-trait-anxiety - theory, and much of this research has employed the STATE - TRAIT ANXIETY INVENTORY (STAI), developed by SPIELBERGER et al.

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*) = Due to the authors personal experience as a moderately experienced parachutist the average dropout rate of student jumpers is as high as 96% during the first ten jumps, i.e. only one in twentyfive novices reaches the eleventh jump (on average the first "free-fall").

This inventory, showing good internal consistency (STAI-Manual, SPIELBERGER et. al 1970), defines TRAIT - ANXIETY as the individual's proneness to experience anxiety in a particular situation as a relatively stable dispositional variable. STATE - ANXIETY is the correspon- ding transitory condition, characterised by feeling of apprehension, tension, heightened activity of the automatic nervous system as a direct consequence to stress-inducing stimuli.

With regard to the character of the stress-inducing stimulus, a distinction has been made between psycholo- gical (threats to self-esteem) and physiological stress (anticipation of physical harm). Given the same situa- tional stress, persons with high A-trait tend to be higher in A-state, and individuals with low anxiety proneness - low A-trait - tend to be lower in A-state. While the absolute magnitude of A-state varies according to A-trait levels, the amount of change in A-state scores during stress does not differ. This was shown, in particular for the case of physical stressors (dental treatment) by LAMB (1976).

A factor-analytical investigation by KENDALL et al (1976) added to the distinction between A-trait and A-state. They found the A-trait scale unidimensional and quite homogeneous, with factor loadings of +.50 in one factor in 14 out of 20 items. This factor was labelled "Cognitive Anxiety", operational to the description of ego-threats (in the 14 items) rather than physical threat situations.

For A-state two factors were found, which seem to corres- pond to the descriptors used in the scale (and may represent artefacts of the scoring system).

To validate their findings, KENDALL et al (1976) further investigated the reliability of the two A-state factors in stressful situations, using both psychological and physiological stressors. The results supported the above outlined trait-state distinction and underlined LAMB's (1976) findings in general. Some interesting indications were also given: A-Trait scores showed a tendency to fluctuate with time and situation.

Using a physical stressor, it was found that both A-state factors reflected stress well, and in addition, that both low and high A-trait levels tend to converge to the same overall A-state score, which seems to indicate that the mere amount of stress should be considered an additional variable. This could be explained by the fact that, as the factor loadings above showed, A-trait is orientated to reflect the reaction to psychological threat rather than to physical harm - stimuli.

In concluding this brief review it may be summarized that LAZARUS's theorem of interaction of personality traits and coping has been supported on the whole. Especially the importance of the group of "ego resources" has been highlighted and the development of the State-Trait-Anxiety - model seems to open a new field for refined investigation of the influence of anxiety on the coping process.

This consolidation may be considered as the initial encouragement for the project on hand. In the investigation it is attempted to establish a directly predictive link between a syndrome of primary personality factors and anxiety traits and coping as a highly specialised operational performance under stress.

The next section will cover the underlying hypothesis and the experimental layout in more detail.

## 4. DESIGN OF THE EXPERIMENT

### 4.1. BASIC HYPOTHESIS

Following LAZARUS' theorem, personality factors, especially what he labelled 'ego resources' and anxiety play a vital role in the coping process, partly directly and partly via appraisals. Research since then has generally confirmed these facts and on the part of anxiety, the phenomenon has been researched in greater detail.

The basic hypothesis underlying this project can be formulated as follows:

> Coping in a task-performance-situation under stress is (also) determined by and can be directly predicted from a quantifiable syndrome of measurable personality factors.

The detailed definitions of the main components of the hypothesis are:

- Coping is understood as achieving the objective of the task satisfactorily, i.e. performing well according to set standards.
- Stress is mainly understood as task-based stress, increased by eventual failure-stress.
- Direct prediction implies that it is possible to establish a predictive link between personality-structure and performance in the task without any reference to or dependence on the internal mechanics of the actual coping process.
- Quantification of the syndrome imposes the constraint that the syndrome's structure can be defined by computable variables.
- Measurability of the personality factors restricts the investigation to the use of recognised personality-tests.

It might be helpful for better understanding of the detailed derivates of the basic hypothesis and the set of supporting assumptions, if a brief anticipatory description of the experimental layout is given here.

The task given was the control of a Chemical-Plant-Simulator. Task-based stressor was a series of 'emergencies', i.e. simulated breakdowns, .The required performance was a combination of fault-finding and corrective action. The pattern of emergencies was such that complete success within the allowed time was impossible and furthermore, failure to cope with each emergency in time increased the complexity and magnitude of the overall problem.

The objective of the task was explicitly defined.

HACKMANN (1970) introduced a framework for the description of tasks and task performance in research on stress, which was found quite useful for detailing and operationalizing the basic hypothesis.

HACKMANN distinguishes between the objective stimuli input and the psychological interactions in assessing the effects of tasks. The objective task input is 'redefined' by the individual corresponding to his personality structure. Then a 'hypothesis' on how to cope is formed, followed by the 'process' of coping with the task which leads to a 'trial outcome'. 'System evaluation', i.e. task-inherent feed back, and 'personal evaluation' might result in adapting the 'hypothesis' until a 'final outcome' is produced.

Using the terms of HACKMANN's framework, the hypothesis, incorporating the essentials of the experimental layout, can be described as follows (an illustrating diagram is given in Fig. 1. p.18):

The task stimuli were the objectives of the task and the actual indications of the 'emergency'. The redefinition introduces task-based-stress, which influences the formulation of the hypothesis, i.e. the intended coping strategy. Also of influence is an increment in the task based stress, initially only determined by anxiety. The process of action taken results in indications of the system, which are interpreted in the personal evaluation of this 'trial outcome'. Depending on the outcome of this evaluation, the hypothesis is adapted or confirmed. If the personal evaluation was positive, no additional stress occurs. If the trial outcome was taken as unsatisfactory, additional stress in the form of task-based-stress (through the now increasing complexity of the task) and failure stress occurs, which results in a consequent redefinition of the task. This feed-back-loop continues until the time limit has expired and/or the experiment is terminated.

The similarity of 'redefinition' and 'personal evaluation' in HACKMANN's framework to LAZARUS'S primary and secondary threat appraisal is obvious. Following the summary of LAZARUS's theorem of interaction between personality factors and the coping mechanisms, ego resources would be of determing influence on 'hypothesis' and 'process', while anxiety would determine the stress increment in or due to its influence on the threat appraisal. (The layout being a continous loop blurs the distinction between primary and secondary appraisal to some extent).

It was furthermore expected, that the very condition of increasing stress and increasing complexity of the task and the thus decreasing probability of solving the task problem consequential to coping failure in the outlined experimental design should amplify and 'purify' the influence of personality factors and lessen the importance of cognitive or intellectual resources considerably.

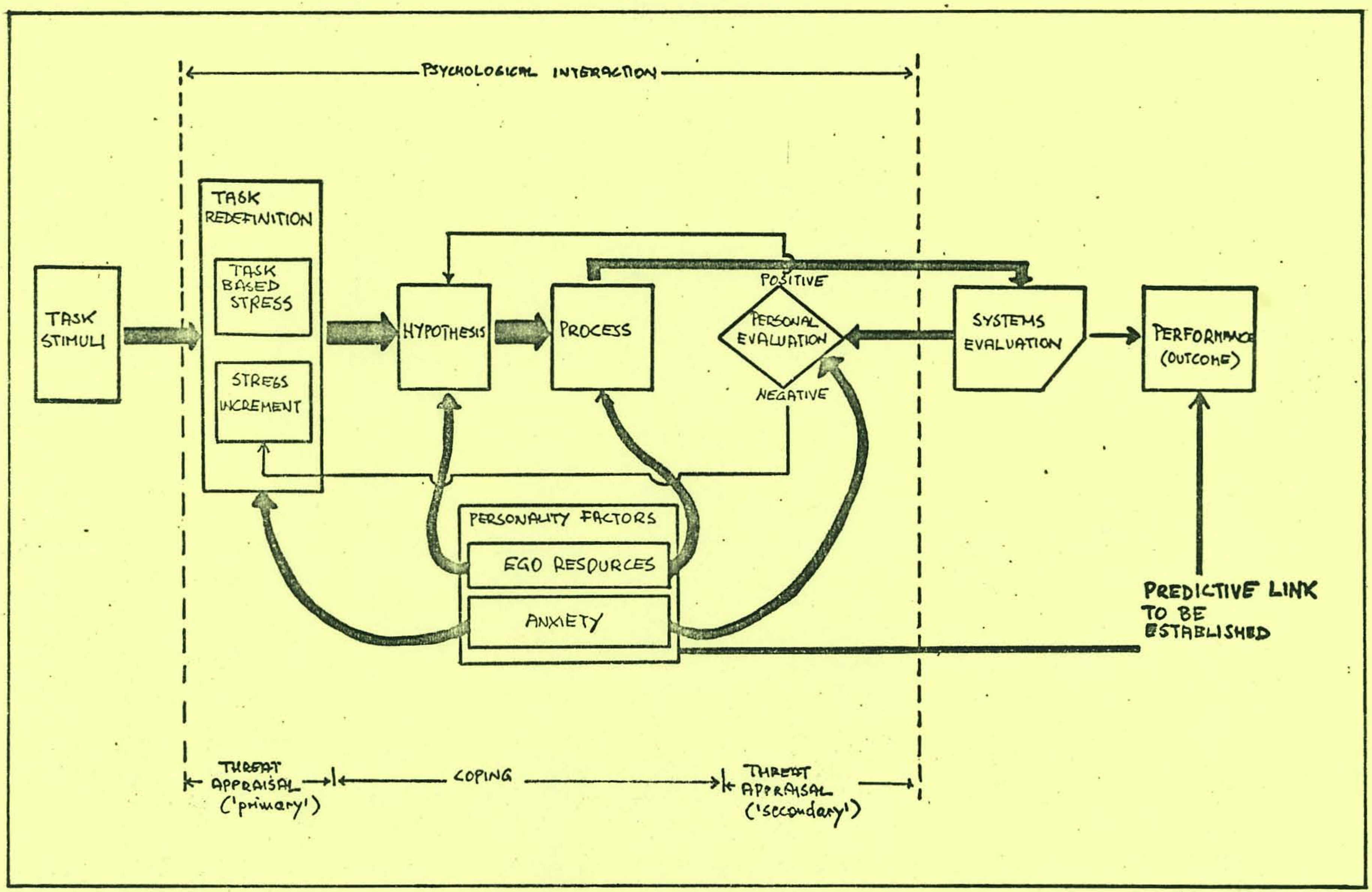



Fig. 1. Framework of the basic hypothesis (after HACKMANN)

## 4.2. EXPERIMENTAL LAYOUT

The participants in the experiment were 35 Plant-operators and 17 Plant-operator trainees, all white males and employees of AECI LTD, Umbogintwini Factory.

All 52 S's underwent a two weeks training, resp, re-training course at the factory training centre, consisting of one week theoretical training on technical equipment and second week of intensive training on operating a chemical-process-plant, using the CHEMICAL PLANT SIMULATOR.

During the first week the S's completed the personality and intelligence tests and the A-Trait questionaire in group administration.

The actual experiment on the Simulator was carried out during the last day of the second week. Each participant was given the A-State questionaire to complete immediately before his 'turn'.

The 'outcome' of the simulator task, i.e. the level of performance for every subject was assessed individually during task-completion by an experienced trainer. To increase the accuracy of the assessment, the task was broken down into a series of logical components and a rating score was issued at every step.

Thus a set of data, comprising a profile of personality factors, an estimate of the intelligence level, scalars for State- and Trait-Anxiety and a rating score of task-performance, complemented by records of age and previous experience as plant-operator were obtained for further statistical analysis.

Details of the psychological tests used, the simulator-task and the statistical analysis are to follow further below.

The 'field work' was carried out from July 1976 to early November 1976 at Umbogintwini.

### 4.2.1. Selection of psychological tests

The selection of the personality inventory to use followed in general the selection criteria listed below:

- The inventory had to be comprehensive. Since in many ways this project can be considered a 'pilot-study', and no particular cluster of personality factors was to be assumed influentially a priori, the inventory used was to have a fair degree of generality, covering as wide a spectrum as possible.

- The test would be established and proven. The small size of the sample used would result in quite broad confidence limits. To minimise an error-variance introduced by a test lacking the desired levels of reliability and validity, this constraint was imposed.

- Also to ensure a minimum quality level of the ensuing statistical analysis the measurements attained with the test should be clear and statistically sound.

- Considering possible further use, the test should be economical in use.

  Evaluating several inventories according to these criterias, it was decided to use the CATELL SIXTEEN PERSONALITY FACTORS test.

This test has been standardised on vast populations (CATELL et al. 1970),is reasonably factorially valid (as recently shown by KARSON et al, 1974) and is in wide use for a wide variety of projects. (A scan through recent literature revealed the following articles: BOWMANN et al. 1974; BARTON et al. 1972, 1973, BACHTOLD et al. 1973; MYRICK et al. 1972; ASHTON et al. 1972, 1972)

The STATE TRAIT ANXIETY INVENTORY (SPIELBERGER et al. 1970) was used because it seems to be at present the best inventory to measure A-State and A-Trait with an optimum in accuracy of the score-scalar and economy of use.

It was felt that some measure of intelligence levels was needed. Since a reasonably reliable unifactorial measurement with good discrimination in the medium to lower intelligence range was felt sufficient, RAVEN's PROGRESSIVE MATRICES TEST was chosen.

### 4.2.2. The simulator task

The Chemical Plant Simulator used is a single three tank-three pump System, but equipped with most of the controls and features of a real chemical process plant. A flow diagram of the CPS is enclosed in Appendix A.1.

The operation simulated in the experiment was control of an acid plant, and the task objective was explicitly defined in terms of flow rates, pressure rates and tank levels.

The 'plant' was handed over to the subject in perfect (i.e. fully conforming to the above definitions) running conditions. It was then explained to him that he was to hand over the plant in these conditions at the end of the 'shift' (i.e. 30 minutes). Eventual faults have to be diagnosed and corrected.

After a 'warm-up' of two minutes a series of faults were introduced by the Training Officer in charge from a remote control console. A set of altogether five fault-conditions, standardized in time and character, was used. (A detailed description is enclosed in App. A.2.)

The timing was chosen such that correcting the fault was just not quite possible, resulting in a constant state of emergency. The sequence of fault conditions was furthermore selected in a way that failure to cope with each emergency fairly rapidly increased the magnitude of the overall problem.

The fault finding and correcting for each set of conditions was broken down into logical steps. The performance in each step was rated by the Training Officer. Fault finding and correction were uniquely defined for each step.

The task-based stressors were:

- Overall time limit of thirty minutes, whereby the elapsed time was visually displayed.
  The Training Officer also gave a verbal 'count-down' in five minute intervals.

- The increasing complexity of the task itself.

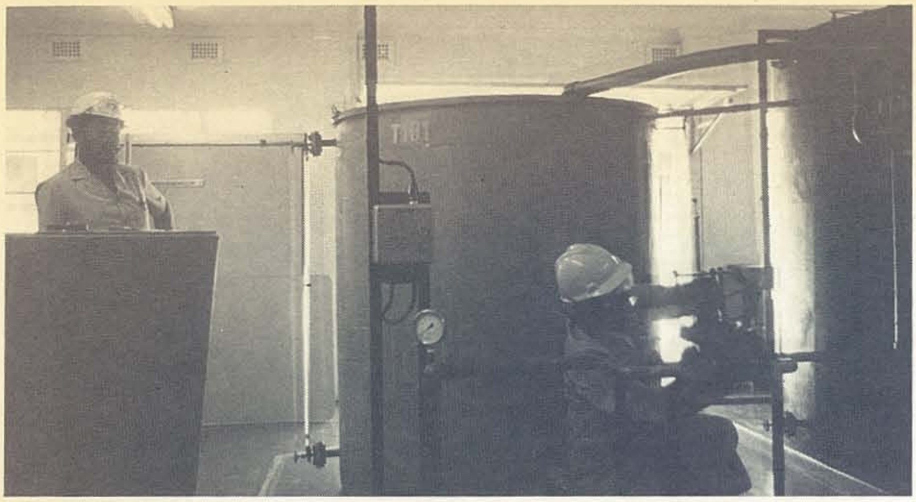
- High achievement pressure, introduced by enforced self-reliance: The subjects only alternatives were to either overcome the emergency without help or to initiate a complete shutdown of the plant (which had been reinforced during the previous weeks of training as the greatest possible evil ever to befall any operator).
  In the case of gross failure, the Training officer would declare 'catastrophic conditions' (i.e. uncontrollable overflow of acid and escape of highly toxic fumes) and terminate the experiment.

- Noise, caused by the simulator itself and two very loud alarm sirens, which were turned hypersensitive for the experiment.

- Uncomfortable and hindering protective clothing (hard-hat, dust-coat, gum boots, goggles, ear-muffs, rubbergloves and respirator).

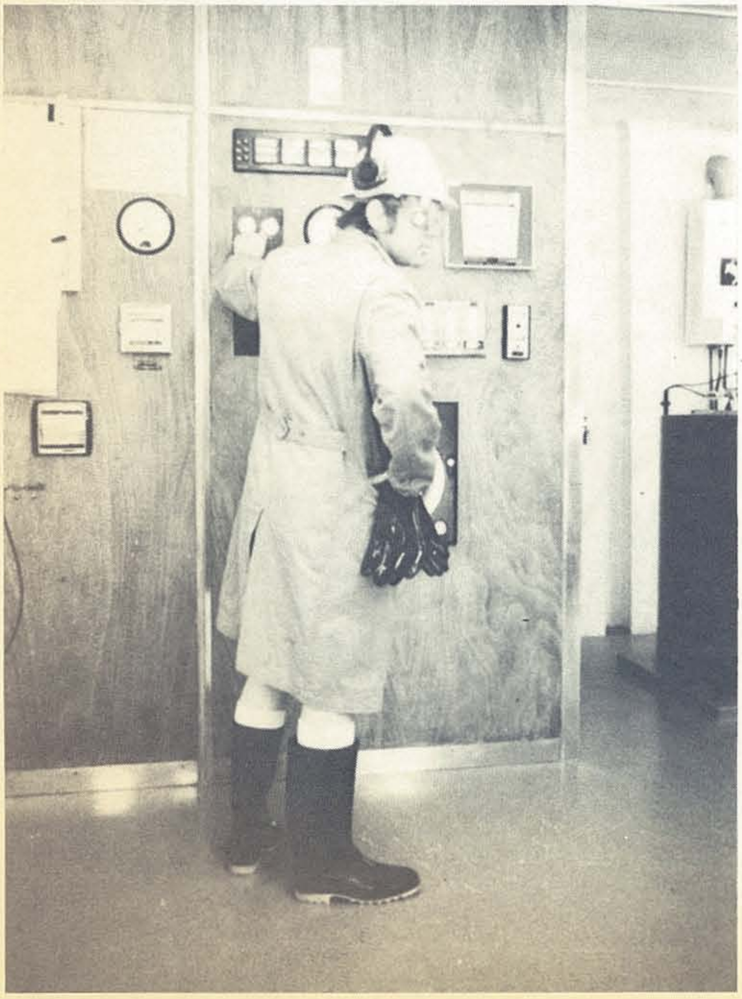
A considerable potential of failure stress can be assumed.

An illustration of the simulator is given in Fig. 2.



*'Corrective action' in a 'hazard area'. The back of the remote-control-console can be seen on the left.*

*View of the main circuit.*



*View of the control panel.*

## 5. STATISTICAL ANALYSIS

The objective of the statistical analysis was to establish a directly predictive link between a set of personality factors and the performance in the simulator-task.

The direct way seemed to be the use of Multiple Regression Analysis as the main analytical tool.

The applicability of Multiple Regression Analysis depends mainly on two conditions:

A. the measurements for all variables have to have at least interval-scale-properties.

B. the sample-population dealt with should be homogeneous with respect to its representativeness of the universe to be inferred.

Ad. A. While interval-scale-properties may be assumed to some degree of validity for the test-scores obtained by the psychological tests, the quality of the measurement applied to performance in the simulator-task had to be investigated. Applying criteria outlined by Guilford (1954) sufficient approximation to an interval-scale was concluded.

Ad. B. The sample dealt with consisted of two different groups: Operators and trainee operators. Several facts indicated that there should not be a significant difference between the two groups. An Analysis of Variance supported this assumption.

The Multiple Regression Analysis was carried out in several steps: first a linear model was fitted, secondly the fitting of a second-order-equation was attempted. The hyperplanes created by the quadratic model were finally investigated in a Response Surface Analysis.

In the following section the methods of Multiple Linear and Quadratic Regression as well as the principles of Response Surface Analysis are described in more detail. The chapter is then concluded with a scrutiny of the basic statistics concerning the statistical analysis.

## 5.1. Multiple Regression Analysis and Response Surface Analysis

The basic model to be fitted to a set of observations in a Multiple Regression Analysis is of the form

$$Y = b_0 + b_1 x_1 + b_2 x_2 \text{ .......... } + b_n x_n$$

whereby Y is called the dependent variable and $x_1$, $x_2$ ... $x_n$ are the independent variables. The 'constant term' $b_0$ and the coefficients $b_1$, $b_2$ ... $b_n$ determine the form of the equation.

In a Multiple Regression it is thus attempted to construct an equation such that for any particular set of values of the independent variables an expected value for the dependent variable can be estimated.

According to the basic hypothesis the variable to be predicted, i.e. the 'dependent' variable, is to be the performance in the simulator-task. The hypothesis further states that the dependent variable is to be predicted directly from the personality factors that characterise the performing individual, i.e. the 'independent' variables.

The above regression equation provides the tool for this direct prediction.

To obtain an estimate for the 'real' relationship of variables as determined by constant term and coefficients, the Multiple Regression method 'fits' a model to the observational data. The 'fit' is achieved by obtaining a solution for the least squares "best" values for the coefficients for the particular set of equations defined by the sample of observations. The solution also provides a measure of the reliability of each of the coefficients so that inferences can be made regarding the parameters of the population from which the sample was taken.

There is a multitude of techniques available to obtain the multiple regression solution (DAVIES, 1968 gives a brief summary of the major techniques).

The algorithm selected for this project was developed by EFROYMSON, 1967.

This technique adopts a stepwise procedure and uses the Gaussian elimination method to solve the Normal equations.

In the stepwise procedure one variable at a time is added and thus the following intermediate equations are obtained:

STEP 1 $\quad Y = {}_0b_0 + {}_0b_1\, x_1$

STEP 2 $\quad Y = {}_1b_0 + {}_1b_1\, x_1 + {}_1b_2\, x_2$

STEP n $\quad Y = {}_nb_0 + {}_nb_1\, x_1 + {}_nb_2\, x_2 \quad + {}_nb_n\, x_n$

The variable added is the one which makes the greatest improvement in the overall 'Goodness of Fit' (i.e. the multiple correlation coefficient of the variables included in the particular sub-equation). The coefficients represent the best values at each stage the equation is fitted by the specific variables included in the equation.

The selection of variables to enter the equation is governed by F-values, or 'F-levels' as they will be called further on, which are supplied by the experimenter, obviously to suit the specific conditions of the observational data and the level of significance to be achieved.

The criterion used to select the $x_i$ variable to enter or leave the regression equation is thus:

- If the variance contribution of a variable in the equation is insignificant at the specified 'F-level to leave', this variable is removed from the regression.

  If no variable is to be removed, then the following criterion is used:

- If the variance reduction obtained by adding a variable to the regression is significant at a prespecified 'F-level to enter', this variable is entered into the regression.

In the technique used this decision of adding or removing is made at each stage in the elimination procedure, so that not only the final solution is of interest, but at every stage a "partial regression equation" is produced, whereby the - significant - variables already eliminated are in the equation, others are not. According to the add-or-delete decision, the elimination procedure is then "reset" at each stage.

This clever combination achieves an optimum of automatic procedure on one side and a great deal of experimenter-control on the other.

Multiple regression can also be used for nonlinear models of the general form:

$$Y = b_0 + b_1 z_1 + b_2 z^2 + b_3 z_1 z_2 \dots + b_n f_n (z_1, z_2 \dots\dots, z_m)$$

In the specific case of a quadratic model with n basic (linear) terms the regression equation takes the form:

$$Y = b_o + \sum_{i=1}^{n} b_i x_i + \sum_{i=n+1}^{2n} b_i x_{i-n}^2 + \sum_{i=2n+1}^{\frac{n}{2}(3+n)} b_i x_{i-2n} x_i$$

This equation is made equivalent to the basic regression model of

$$Y = B_o + \sum_{i=1}^{M} B_i V_i$$

by the substitutions:

$$V_i = X_i \text{ for } n \geqslant i \geqslant 1$$

and $$V_i = X_{i-n}^2 \text{ for } 2n \geqslant i \geqslant n+1$$

and $$V_i = X_{i-2n} \qquad \text{for } \frac{n}{2}(3+n) \geqslant i \geqslant 2n+1$$

which means that each power or product entering the regression equation is treated as if it were a seperate independent variable in setting up the least-squares equations for the regression coefficients, i.e.:

$$V_1 = X_1$$

$$V_2 = X_2$$

$$\vdots$$

$$V_n = X_n$$

and $$V_{n+1} = X_1^2$$

$$V_{n+2} = X_2^2$$

$$\vdots$$

$$V_{2n} = X_n^2$$

and hence $$V_{2n+1} = X_1 X_2$$

$$V_{2n+2} = X_1 \; X_2$$

$$\vdots$$

$$V_M = V_{\frac{n}{2}(3+n)} = X_n \; X_{n-1}$$

The maximum value of the subscript M of the transformed variables out of n basic variables thus consists of n linear terms

+ n square terms

+ $\frac{n}{2}$ (n-1) cross products

This steep increase in (secondary) variables somehow limits the applicability of Multiple Quadratic Regression Analysis. On the other hand, the inclusion of cross products widens the scope of the analysis considerably as interactions can be of particular interest especially with psychological variables.

A common difficulty experienced with Multiple Regression Analysis is that generally the full implications of the relations expressed in the regression equation are hard to comprehend and interpret, the more so, when the number of independent variables increases.

The problem escalates drastically if a higher order model is fitted.

Several techniques have been developed to aid in the interpretation of complex regression equations.

A very helpful technique especially with smaller samples and in pilot studies, is the construction of a profile based on the coefficients obtained for the set of independent variables conducive to a specified level of response. Since the independent variables are personality factors which are generally displayed in the form of a profile this technique is particularly applicable and was used in the interpretation of the linear regression equation.

A further technique used to investigate complex relationship of variables is Response Surface Analysis.

Any equation can be interpreted geometrically according to the number of variables it contains, i.e. two variables define a curve, three or more a plane or a hyperplane.

The regression equation containing only the dependent variable (the 'response') and one independent variable therefore would yield a two dimensional curve. If two independent variables are included in the equation, the relationship may be represented as a three-dimensional surface, called the Response Surface (RA).

The common way of a graphical display of the RA is the drawing of lines of equal response in a two dimensional graph whose co-ordinates denote the values of the independent variables. These contour lines (termed Response Contours) may then be read like a geographical map or a weather chart: Contour lines which are close together in any region imply a rapid change in the response for relatively small changes in the variables, and vice versa. Thus the direction and steepness of ascent/descent in response for sets of variable-configuration can be investigated. A linear regression equation produces a set of straight-line contours.

For a quadratic relationship, contour lines generally consist of either concentric ellipses, concentric hyperbolas or open-ended parabolas. Ellipses indicate a positive minimum or maximum, hyperbolas imply a 'saddle' and parabolas can be interpreted as a 'ridge'.

The technique of Response Surface Analysis had been originally developed for the chemical industry. (BOX, 1960; DAVIES, 1968; BOX AND DRAPER, 1969), but at least one application in psychological research could be found in the literature (CLARK & WILLIGES, 1973, MILLS AND WILLIGES, 1973).

In this project Response Surface Analysis was used as an additional investigation to explore the regression equation obtained by the Multiple Quadratic Regression Analysis.

## 5.2. Basic Statistics

In this section three topics will be discussed:

- Sample characteristics
- Quality of the rating-scores for performance in the Simulator-task
- Procedure and F-levels for the MRA's.

Appendix B contains all the relevant graphs, tables and illustrations for this section.

Sample characteristics

Overall sample size was 52 Ss.

The sample contained two groups:

- NEW STARTERS, i.e. Ss who were newly employed and were undergoing the compulsory induction training
- RETRAINED OPERATORS, i.e. operators on a retraining session

To clarify the question of sample homogeneity, an Analysis of Variance was carried out. The analysis principally indicated no significant differences between the two groups, although not quite conclusively: Due to differences in magnitude between the scores (STENS vs. untransformed Performance-scores) high SS's of ERROR were experienced, which could method-inherently supress significancy in extreme cases.

Further findings, however, support the 'no-difference' hypothesis:

- Considering the mean profile in the 16PF-scores it appears that the experimental group represents a "good mix" with no characteristics in the profile. With three exceptions (B+, L+, Q2+) the mean scores lie within the range of STENS 5 and 6, which represents 38,2% of the underlying score distribution, and is the "average" range.

The Intelligence- and Anxiety-mean scores are also fairly close to the average range, although Intelligence represents the highest mean-score of all the psychological variables.

- 'Experience', the factor mainly expected to influence the performance-score and thus distort a relation between personality factors and performance, had a highly skewed distribution with the main bias towards 'lesser experience': nearly 50% of all participants had less than one year of experience as a plant operator.
- Another factor, supporting the hypothesis of a homogeneous group, was the relative simplicity of the actual operation of the simulator together with the extensive specific training given. Thus the initial training for 'new starters' proved to be enough counterweight to offset the advantage of previous experience on the side of the 'retrained operators'.

Considering these additional facts, it was felt that the hypothesis of sample-homogeneity was sufficiently supported.

The age distribution is also fairly skewed towards the age group of 19 to 25.

(These highly skewed frequency-polygons of 'AGE' and 'EXPERIENCE' were the main reason that these two variables were later excluded from the further analysis).

To standardise the range of numerical magnitude of the test scores for the psychological variables, all test scores were transformed to STENS.

The score for performance in the Simulator-task, although showing a good approximation of a Normal distribution, was not transformed into STENS, with its confidence interval being 17, 24 and a STEN-width of only 18,5, the probality of an 'overlap', i.e. the 'true' value might lie in any one of two neighboured STENS would introduce an actually uncontrollable second-order error.

## Quality of the rating scores for performance in the simulator task

The total score for performance here was the sum of ratings issued in each of the logical steps of the task. The applied rating was numerical.

In strict terms of measurement theory therefore, the scale thus constructed should principally be considered an ordinal scale, and therefore certain restrictions in the choice of methods of statistical analysis apply.

As GUILFORD (1954) points out, however, a numerical rating-scale can be considered to hold at least interval-properties, if certain qualitative and quantitative criteria are applicable:

- Sufficient experience of the rating individual
- Simplicity and directness of the allocation of number properties to the observations

The rating was done by an experienced training officer. The procedure of rating was simplified by comparing the rating (from one to ten) to giving "schoolmarks" in full percentages only.

To increase the directness of the rating, the performance to be judged was broken down into as many little units as logically possible.

GUILFORD (1954) suggests two empirical checks, mainly to ensure rating-consistency:

a. the frequency - distribution of the rating scale should not be different from the distribution of the rated phenomenon,

b. the ratings should be considerably reliable (in terms of test-reliability)

<u>Ad a.</u> Performance was rated positively, i.e. the rating depends on the appearance of a certain reaction (corrective action) to a standardized stimulus (the "fault"). The reaction "chosen" stems from a finite set of possible reactions.

Thus the phenonenon is primarily binomially and consequently normally distributed.

A simple check (using the Chi-square method, Pfanzagl 1966) showed that the obtained distribution of rating - scores is not significantly different from a normal distribution (95% significance-level).

<u>Ad b.</u> The parameter chosen for estimating the consistency of the rating-scores was a split-half-correlation.

The observations were thoroughly mixed, to achieve a quasi-random sequence, separated in a one-for-one mode and rearranged into two distributions. Then the correlation-coefficient was computed. Simultaneously a regression equation for the "first" half on the "second" half was established.
The correlation-coefficient is high (0.9683) and the regression-coefficient close to 1.0, so that a fair consistency of ratings can be assumed.

The analysis of the data thus sufficiently supports the assumption that the performance score can be considered a measurement from an interval-scale.
Hence its use in a regression analysis can be considered statistically justified.

The analysis of the distribution of the simulator-scores also served its purpose as a check against any existing constant errors (commonly expected in any rating).

The rather slim distribution (with a coeffiecient of variation *) of 19.9 the narrowest of all) indicates the presence of the error of "central tendency" (GUILFORD, 1954). The reason for this can probably be found in too markedly a formulation of the end-of-scale statements as "extreme poor-", resp. "extreme good performance".

The slight "overweight" on the high-score side of the distribution suggests the existence of the "error of positive leniency" (GUILFORD 1954), i.e. a one-sided bias in form of a tendency to allocate higher scores.

This is partly underlined by the fact, that the regression equation obtained for the two "half" - distributions contains a positive constant term (although here it is equally probable that the quasi-random sequence of the observations was not randomised sufficiently before the split).

Both errors, although recognisable, were not considered serious enough to have a significantly biasing impact on the obtained results.

There were 28 logical steps in the task at which ratings were issued. The ratings ranged from 1 ('extremely poor performance') to 10 ('extremely good performance').

The maximum score was therefore 280; the minimum, however was 9 and not 28: This was the point at which, with no corrective action taken, the accumulated effects of the faults had reached "catastrophe" - level and the Training Officer had to initiate a shutdown of the simulator.

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*) = This statistic is usually not applicable to an interval scale because it assumes an absolute origin of zero. Since this condition, however, applies in a very common sense to test-scores (if we equate 'not measureable' with zero) the coef. o.v. is used for demonstration purposes only throughout this thesis.

Procedure and F-levels for the MRA

Every MRA was initially carried out as a survey analysis without any reference to significance of included variables. This was done to check mainly for algorithm validity and to gain a first impression of variable configurations.

The consequent MRA's were carried out with applying the appropriate F-values, which are defined as follows:

- The F-level for a variable to enter the equation is determined by the F-ratio within the total number of variables.

- The critical F-value for a variable to be removed from the equation is determined by sample-size versus the number of variables.

The applied F-levels were:

| MRA | F-Level ENTER | F-Level LEAVE | No. of variables |
|---|---|---|---|
| MLRA III | 2,12 | 1,74 | 19 |
| MLRA IV | 3,18 | 2,07 | 9 |
| MQRA II | 1,88 | 1,69 | 27 |
| MQRA V | 2,48 | 1,89 | 14 |

Throughout the statistical analysis a significance level of 95% was applied.

# 6. FINDINGS

## 6.1. MULTIPLE LINEAR REGRESSION ANALYSIS (MLRA)

### 6.1.1. SUMMARY OF FINDINGS

Four sets of variables were analysed in MLRA I to MLRA V.

The first analysis MLRAI included all basic variables, i.e. all 16-PF, STATE- and TRAIT-ANXIETY, INTELLIGENCE (RAVEN PM), AGE and Experience.

To gather a first overall impression of the possible structure of the regression equation and in order to carry out certain checks to determine the validity of the algorithm, all variables without reference to their significance were allowed to enter the equation.

The thus fitted model achieved a fairly high Goodness of Fit, i.e. it can be expected that a high proportion of variance would be "explained" by the model. The structure of the model indicated that the variables 16PF-Q3 (SELF-CONCEPT-CONTROL), 16PF-L (ALAXIA), 16PF-L (EGO-STRENGTH) and TRAIT-ANXIETY would probably be of importance in the final model. Due to their skewed distribution, the variables AGE and EXPERIENCE were excluded from further analysis. Otherwise this analysis confirmed the validity of the algorithm used.

The exclusion of two variables, however, made a second survey - analysis recommendable. MLRA II confirmed and stabilised the structure of the model indicated by MLRA I. Additional variables such as INTELLIGENCE (RAVEN PM) and STATE-ANXIETY gained importance. The exclusion of AGE and EXPERIENCE had only a minor effect on the Goodness of Fit.

In MLRA III only significant variables

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N.B.: <u>A COMPENDIUM OF BRIEF DESCRIPTIONS OF THE PERSONALITY VARIABLES USED IS INCLUDED AS A FOLD-OUT ON THE LAST PAGE OF THIS THESIS.</u>

were included into the fitted model. The model included eleven significant variables and achieved a Goodness of Fit of 82,5%. The configuration of the eleven variables conducive to good performance can be clustered into a syndrome of three main groups of personality traits and two clusters of lesser importance:

1. EGO STABILITY CONTROL (low 16PF-L, low A-TRAIT, high 16PF-L)

2. SELF ORIENTATION (high 16PF-Q2, low 16PF-Q3, low 16PF-G, low 16PF-I)

3. ACTIVATION POTENTIAL (high A-STATE, high 16PF-Q4)

4. CYCLOTHYMIA (high 16PF-A)

5. INTELLIGENCE (below average).

Since this construct follows roughly the relation between Cattell's first order traits to second-stratum factors, in MLRA IV it was attempted to fit a model using these second-stratum-factors as basic variables.

MLRA IV was completely unsuccessful: the survey-analysis (including all variables regardless of their significance) achieved a fit of only 41,8%, to which TRAIT-ANXIETY (being substituted for Cattell's QII) was a major contributor. Considering only significant variables, it proved impossible to fit an equation at all.

The following is a more detailed description of MLRA I to MLRA IV.

All relevant illustrations (print-outs, etc) can be found in Appendix C.

### 6.1.2. MLRA I: ALL VARIABLES/F-LEVELS SET TO 0.0

Variable 16PF-Q3 shows by far the highest significant contribution.

The positive coefficient (high, small variance) indicates that the Q3-high-score manifestation ("High self concept control") is of relevance. Having only entered in the fourth step with a fit contribution of only 8.2%, Q3 gained importance during the steps.

Trait-anxiety, supplying the greatest fit-contribution, is the second highly significant variable. Its negative coefficient (high, small variance) emphasises the low - score range of the variable. A-Trait has also gained significance during the selection procedure.

The third variable with a two-digit F-value is 16PF-L in the low-score - manifestation ("Alaxia"). The coefficient is fairly stable with a variation of roughly 19% *). Entering in Step 2, 16PF-L is second in fit contribution (23%).

"High Ego Strength" (16PF-C+) is ranked next, following by "State-Anxiety", which is interestingly represented in the high - score - range.

The coefficients for both variables show a variation around 20%.

("Experience", which showed also high contribution, will be dealt with later).

The least significant variables were:

- 16PF-O (Untroubled Adequacy vs. Guilt Proneness)
- Intelligence (Progr. Matr. Test), which is surprising, because 16PF-B is fairly significant contributor.

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*) = STD. DEV expressed as percentage of the estimated coefficient.

- 16PF-N (Artlessness vs. Shrewdness)

- 16PF-E (Submissiveness vs. Dominance)

and - 16PF-F (Desurgency vs. Surgency)

The equation achieved a Goodness of Fit of 90, 99%, with a standard error of the derived estimate of 14.478 (i.e. a confidence interval of $\pm$ 24,32 on a significance level of 95% applies).

As an additional check, the residuals (i.e. the deviations between observed values for the simulator score and estimates, calculated via the obtained equations) were plotted against each variable in turn, including the dependent variable. Davies (1968) suggests this visual, but powerful technique for the following reasons: a major assumption underlying MLRA is, that the residuals, i.e. errors unexplained by the independent variables are independent with zero mean, constant variance and consequently Normally distributed. If these assumptions are fulfilled, the residuals should lie roughly in a horizontal bank around the mean of the independent variable, looking "randomly".

With two exceptions, all variables indicated Normally distributed residuals, although in some cases curvatures were suspected.

Age and Experience, however, due to their highly skewed distribution, gave a fairly distorted picture.
Since "freak" observation—distributions can easily produce algorithm—inherent artefacts (Davies, 1968), it was decided to eliminate these two variables from the further analysis: the relatively high fit contribution of Experience is considered to be mainly due to such method particulars, and Age proved to be rather insignificant in any case.

The analysis of the variables in rank order of their contribution to the Goodness of Fit showed the following picture:

| STEP NO. | VARIABLE *) | CONTRIBUTION TO G/F% | G/F% OF SUB-EQUATION |
|---|---|---|---|
| 1 | TRAIT-ANXIETY | 29,3280 | 29,3280 |
| 2 | ALAXIA (L) | 22,9574 | 52,2854 |
| 3 | EXPERIENCE | 7,6938 | 59,9792 |
| 4 | INTEGRATION (Q3) | 8,1580 | 68,1372 |
| 5 | GROUP ADHERENCE (Q2) | 5,5127 | 73,6499 |
| 6 | SIZO/CYCLOTHYMIA (A) | 3,0597 | 76,7096 |
| 7 | STATE-ANXIETY | 3,8142 | 80,5238 |
| 8 | THRECTIA (H) | 1,3450 | 81,8688 |
| 9 | EGO STRENGTH (C) | 2,3929 | 84,2647 |
| 10 | SCHOL. M. ABILITY (B) | 1,8070 | 86,0717 |

The other 11 variables together increased the G/F by a mere 4,9205% to 90,992% G/F of the final equation.

This represents an average G/F contribution of only 0,4473%.

*) 16-PF variables are sometimes named in their low-score manifestation only.

G/F = Goodness of Fit.

### 6.1.3. MLRA II: VARIABLES: 16PF, A-TRAIT/STATE, INTELLIGENCE/F-LEVELS SET TO 0.0

The exclusion of the variables and Experience had mainly a moderating effect on the equation. Also, the structure of the included variables changed.

16PF-Q3 high - score is still the most significant contributor, while 16PF-L (low - score) holds now second rank before Trait-Anxiety (low-score) and 16PF - C (high - score).

Intelligence (measured with the Progr. Matr. - Test) has slightly gained importance, against 16PF-B, which has declined in significance. Interestingly the coefficients have contrary signs: 16PF-B is positively influencing, while the coefficient for Intelligence is negatively represented (i.e. a lower score here is conducive to satisfactory performance).

Another interesting contrast is seen in the configuration of A-Trait and A-State, with A-State being positively and A-Trait - fairly markedly - negatively "loaded".

The traits in rank-order of least significance in this equation are:

16PF-Q1 (Conservatism vs. Radicalism)

16PF-E (Submissiveness vs. Dominance)

16PF1M (Praxernia vs. Autia)

16PF-B (Scholastic Mental Capacity)

The equation achieved a Goodness of Fit) of 85.9% and showed a standard error of estimate of 17.54, which implies confidence limits of +/- 29.47.

The exclusion of the variables Age and Experience has decreased the Goodness of Fit by only 5%. The confidence interval for estimating the simulator - score from the equation has widened from F24.32 to F29.47 (i.e. a percentage increase in width of 8.25%).

An analysis of the variables in rank-order of their contribution to the Goodness of Fit showed the following picture:

| STEP | VARIABLE | CONTRIBUTION TO G/F% | G/F% OF SUB-EQUATION |
|---|---|---|---|
| 1 | TRAIT ANXIETY | 29,3280 | 29,3280 |
| 2 | ALAXIA (L) | 22,9574 | 52,2854 |
| 3 | INTEGRATION (Q3) | 5,6745 | 57,9599 |
| 4 | GROUP ADHERENCE (Q2) | 9,6179 | 67,5778 |
| 5 | SUPEREGO STRENGTH (G) | 3,3845 | 70,9623 |
| 6 | EGO STRENGTH (C) | 2,9920 | 73,9543 |
| 7 | SIZO/CYCLOTHYMIA (A) | 2,2855 | 76,2398 |
| 8 | INTELLIGENCE (RAVEN) | 1,7283 | 77,9681 |

The remaining 11 variables together increased the G/F only 7,928% to a final 85,8968%, which represents an average G/F contribution per variable of a mere 0,7208%.

### 6.1.4. MLRA III: VARIABLES: 16PF, A-STATE/TRAIT, INTELLIGENCE

The equation, containing only significant variables, consists of eleven variables and achieves a Goodness of Fit of 82.4438%, only 3.4538% less than the equation which also included insignificant variables.

The rank order of variables by significance remained unchanged as the following listing shows:

1. 16PF-Q3 (high-score) "High Self-concept Control"
2. 16PF-L (low-score) "Alaxia"
3. A-TRAIT (low-score) low level of trait-anxiety
4. 16PF-Q2 (high-score) "Self-Sufficiency"
5. 16PF-C (high-score) "Higher Ego-Strength".
6. 16PF-A (high-score) "Cyclothymia" (Affectothymia)
7. 16PF-G (low-score) "Weaker Superego Strength"
8. A-STATE (high-score) high level of transient anxiety.
9. 16PF-I (low-score) "Harria"
10. 16PF-Q4 (high-score) "Ergic Tension"
11. Intelligence (low-score)

To gain a better overall picture of the variable configuration, Fig. 3 shows a plot of coefficients against variables, the middle line representing zero and the coefficients directed towards the low or high-score range of the variables according to the sign of the coefficients.

(Coefficients for non-significant variables are set to zero)

Grouping the significant traits, one can separate five clusters of related traits (roughly guided by similar loadings of first - order - traits in second - stratum factors of the 16PF, Catell et al., 1970). Taking into account the particular configuration found, these can be labelled:

- Ego- Stability Control (a-neuroticism, represented by low A-TRAIT, C+, L-, Q3+),

- Self - Orientation (Q2+, G-, underlined by I-),

- Hyperactivation - Potential (Q4, A-STATE, underlined by I-)

  and

- Cyclothymia (A+)

- Low Intelligence

The importance of these five groups of variables for achieving optimum performance seems to follow the above order.

It should be emphasized here that the clustering is merely of a syndromatic nature, i.e. it does not imply any underlying factorial structure of any nature. The "label" given is purely descriptive.

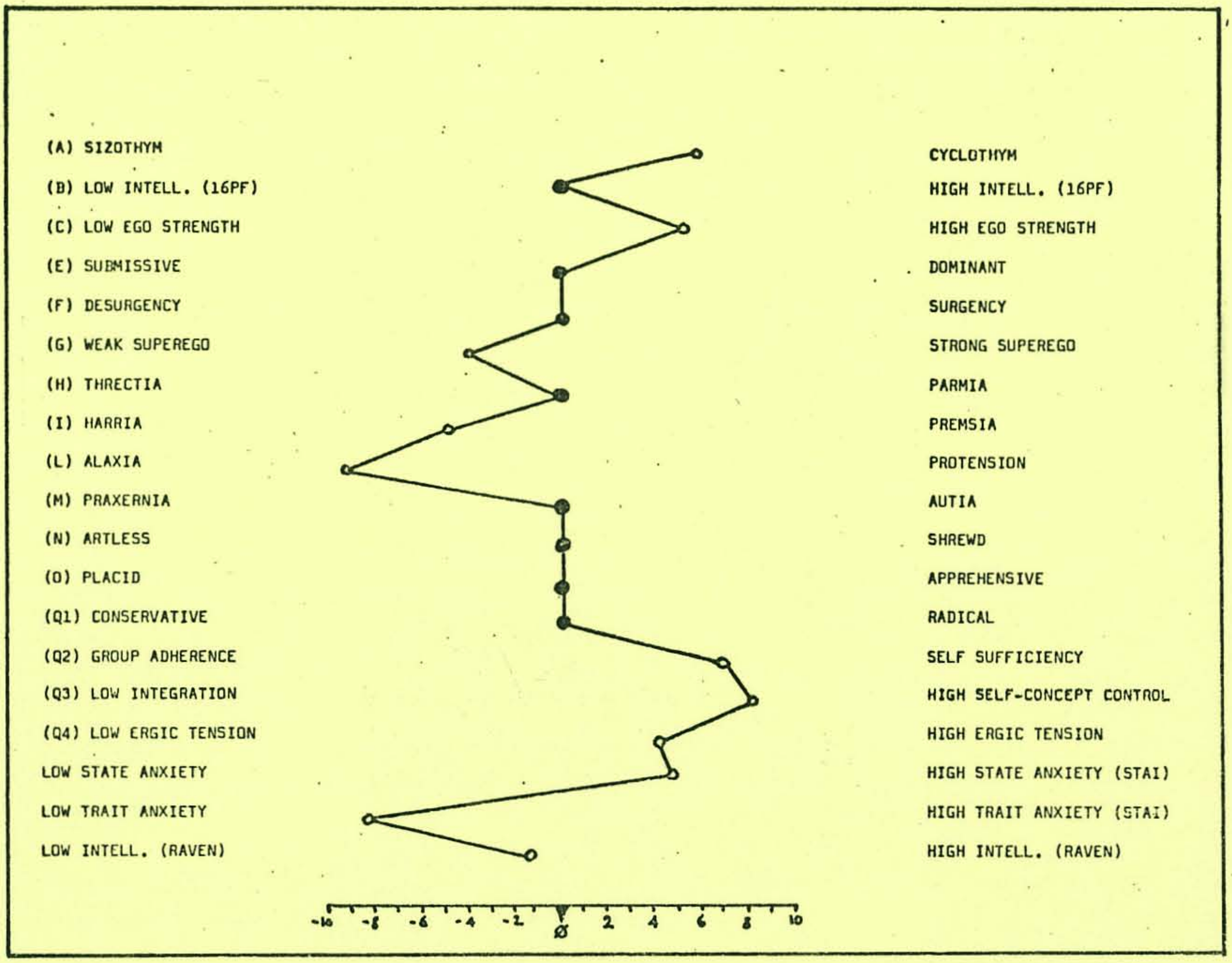


Fig.3. MLRA III-coefficient values in profile.

Since, however, consideration of Catell's second-stratum traits proved helpful to arrange the variables in a psychologically plausible cluster-pattern, it was decided to investigate the predictive quality of second stratum - trait - scores further.

The scores obtained for the first-order-factors were therefore transformed into STENS for second-stratum-traits (using weights and constants of Catell et. al. 1970).

The results of this analysis are described further below.

App. C4 shows the scattergram and the histogram of residuals plotted against the actually obtained simulator score. There is a small bias towards higher scores, i.e. the higher the actual score the more the model over-estimates.

Since a bias in the same direction was found in the basic frequency-polygon of the simulator-scores (possibly due to a "leniency-error" in the rating), the consistent deviation of estimates produced by the equation seems to simply reflect an extrapolation - effect within the model.

The analysis of variables in rank order of their contribution to the Goodness of fit showed the following picture: (see next page).

| STEP NO. | VARIABLE | CONTRIBUTION TO GOODN/FIT | GOODNESS OF FIT OF EQUATION |
|---|---|---|---|
| 1 | TRAIT ANXIETY (STAI) | 29,3280 | 29,3280 |
| 2 | ALAXIA/PROTENSION | 22,9574 | 52,2854 |
| 3 | SELF CONCEPT CONTROL | 5,6745 | 57,9599 |
| 4 | GROUP ADHERENCE/SELF-SUFF | 9,6179 | 67,5778 |
| 5 | SUPEREGO STRENGTH | 3,3845 | 70,9623 |
| 6 | EGO STRENGTH | 2,9920 | 73,9543 |
| 7 | SIZOTHYMIA/CYCLOTHMIA | 2,2885 | 76,2398 |
| 8 | INTELLIGENCE (RAVEN/PROG. MATR.) | 1,7283 | 77,9681 |
| 9 | HARRIA-PREMSIA | 1,3358 | 79,3039 |
| 10 | STATE-ANXIETY (STAI) | 1,4827 | 80,7857 |
| 11 | ERGIC TENSION | 1,6581 | 82,4438 |

The rank order is the same as in the previous analysis (with Zero-F-Levels). No variables have been deleted.

## 6.1.5. MLRA IV: VARIABLES: 16PF-SECOND-STRATUM-FACTORS EXCLUDING: ANXIETY, INTELLIGENCE

F-LEVELS SET TO ZERO

To avoid the amplifying effect of having two correlated variables amongst the independent variables, the 16PF-second-stratum trait "anxiety" was excluded in favour of A-TRAIT (STAI) and 16PF - second-stratum factor "intelligence" was left out because of the presence of the score for intelligence measured by the Progressive - Matrices-Test, which was felt to be a more consolidated and reliable score for this variable.

App. C5 shows the transformed data matrix and the results of this analysis.

This set of variables only achieved a fit of 41.8487%.

The level of significance is fairly low throughout all variables.

However, the important role of A-Trait was supported here again: it is the most significantly contributing variable, and adds 29.328% to the fit. Since the overall fit was only 41.8, the six 16PF - second-stratums together contributed only 12.521% or not even a third of the total fit-percentage.

Two explanations for this surprising result seem plausible:

- The relatively high impurity of Cattell's second-stratum-factors and the particular configuration of their intercorrelations might counteract and suppress the effects attained by the analysis of the first-order-traits.

- Only eight first-order-traits showed a satisfactorily significant fit-contribution in the previous analysis, while the second-stratum-factors were derived from all sixteen primaries.

A further analysis showed that no variable in this configuration is significant enough to model an equation (F-level enter for 9/9 of = 3,18, F-Level for leave for 50/9 of = 2,07).

Applying the F-levels appropriate for the underlying variables (i.e. 2,1244 and 1,7444 respectively), which is statistically dubious and stretches the significance level to an estimated 78%, only produced two variables in the equation.
Expectedly one was A-Trait. Surprisingly the second one was QV i.e. "Discreetness", a second-order-trait that is nearly solely loaded by the primary N, which in turn was found to be highly insignificant in MLRA III.

A possible explanation may again refer to the above mentioned high impurities: QV not only has the highest intercorrelations amongst the 16-PF primaries, it is also highly intercorrelated with nearly all other second-stratum-factors.

Summarizing, it can be said that no significant relation between 16PF-second-stratum-factors and the dependent variable (simulator-score) could be found.

## 6.2. MULTIPLE QUADRATIC REGRESSION ANALYSIS (MQRA)

### 6.2.1. INTRODUCTION

The scrutiny of the scattergrams of residuals, as mentioned in the description of the findings of MLRA I, serves two purposes:

a) To provide a visual check if the underlying assumptions for any MRA are fulfilled, i.e. if the residuals are normally distributed with zero-mean and constant variance. (The inherent Analysis of Variance for the multiple regression demands both criterias, t-tests and F-tests of significance only require Normal distribution). Thus, ill-distributed variables, or outlying observations may be recognised and consequently omitted to obtain an improved fit of the model.

   Furthermore, systematic errors in the analysis might be diagnosed.

b) If the 'band' of plotted residuals describes a curved path rather than a straight line, this could indicate the need for a polynomially expressed underlying relationship.

In MLRA I the examination of the residuals was utilised to delete two variables, and a systematic error (the model's extrapolationary reflection of the 'error of leniency' inherent to the rating) was detected.

In order to investigate if the linear model achieved so far is yielding the optimal degree of fit-exhaustion obtainable through the available observation-data, the scattergram of residuals was scrutinized with respect to curvatures.

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N.B.: Appendix D contains all the relevant print-outs for this section.

A curved path was suspected for seven of the eleven variables that were included in the MLRA III - model.

The variables whose residuals indicated a curvature were:

SIZO/CYCLOTHYMIA (A)
EGO STRENGTH (C)
SUPEREGO STRENGTH (G)
ALAXIA (L)
GROUP ADHERENCE (Q2)
INTEGRATION (Q3)
TRAIT-ANXIETY

Despite the fact that the suspected curvature was not distinct in any of the seven variables (and the selection was therefore somewhat subjective) it was decided to attempt to fit a quadratic model.

Two additional considerations supported this decision:

Davies (1968) suggests that whenever a set of optimum conditions for the independent (response) variable is thought possible, consideration should be given to fitting a second-order-model, especially to multivariable data.

The given experimental layout by definition implies 'optimum conditions'. The test-score-range clearly limits the feasible set of values for the independent variables, and by defining the highest observed performance as the 'maximum response', a set of optimum conditions is formulated eo ipso.

Furthermore, the equation arrived at by the MLRA III does not allow conclusions as to the rank order of importance of variables other than by magnitude of coefficients.

The inclusion of square terms and cross-products in a quadratic model could, however, provide an increased insight into the interdependencies of variables beyond the unidimensional boundaries of the linear model.

Since the amount of terms (t) in a quadratic model constructed of p basic variables increases with $t = 0,5\ p\ (3 + p)$ and, as a general rule (Davies 1968) the number of observations should at least be twice as great as the number of coefficients to be estimated, only six variables could be included in a second order model.

Also the consequences of a quadratic transformation to the significance of variables included into the regression equations had to be considered. The unavoidable increase of artificial intercorrelations between linear terms, square terms and crossproducts can have an uncontrollable influence on variable selection - in particular in the stepwise method, and especially since the algorithm used provides an automatic check against the possibility of 'degeneracy' (Efroymson, 1967). To counteract this only the six most significant variables of MLRA III were to be included in a MQRA.

These were:

SIZO/CYCLOTHYMIA (A)
EGO STRENGTH (C)
ALAXIA (L)
GROUP ADHERENCE (Q2)
INTEGRATION (Q3)
TRAIT ANXIETY

### 6.2.2. SUMMARY OF FINDINGS

Three attempts were undertaken to fit a second order model.

MQRA I was carried out as the initial survey-analysis to obtain an overall picture of the possible structure of the regression equation and to check algorithm-validity.

The high number of variables taken into the equation and the unavoidable lack of variable independence (i.e. increased correlations between linear and square terms and cross-products) resulted in an levelling effect on the importance of individual variables. It could be seen, however, that crossproducts of the basic variables seem to have the main influence.

The achieved Goodness of Fit was quite high with 86,7%.

Applying the significance - 'filters' in MQRA II reduced the number of variables included in the equation to five and only resulted in a drop of the 'explained' variance to 77%. All six basic variables were represented in the model:

- 16PF-L and TRAIT-ANXIETY in their crossproduct term
- 16PF-Q2 in the square term
- 16PF-Q3 in linear form
- 16PF-A and 16PF-C as crossproduct

and - the crossproduct of 16PF-Q2 and 16PF -Q3.

The dominance of crossproducts is a secure indicator for the fact that obviously the interaction of variables is the main determining factor in predicting performance. Furthermore the importance of 16PF-Q2 and 16PF-Q3 is underlined by the individual appearance of both variables.

The configuration of the variables conforms in principle with the clustered syndrome constructed in following the linear model.

MQRA III was conducted as an experiment with subsets of the basic variables.
A survey-analysis with the subset 16PF-A, 16PF-C and 16PF-Q2 only achieved a Goodness of Fit ratio of 30%. Analysing the steps of assembling the final model, Q2 was found to be the main contributor.

The second subset consisted of 16PF-L, 16PF-Q3 and TRAIT-ANXIETY. The fitted model showed a G/F-Ratio of 64%, whereby the crossproduct of 16PF-L and A-TRAIT was the major contributor. It was then decided to form a third subset including 16PF-L, 16PF-Q2, 16PF-Q3 and A-TRAIT. In MQRA IV the survey-analysis was carried out. Allowing only significant variables to enter the model, MQRA V fitted an equation consisting of only two variables and still a Goodness of Fit of 65% could be achieved. Both variables in the equation were crossproducts:

- 16PF-L and A-TRAIT
- 16PF-Q2 and 16PF-Q3

Referring to the syndrome derived from the linear model, this result clearly puts a strong emphasis on the predictive value of the clusters 'EGO STABILITY CONTROL' and 'SELF ORIENTATION'.

The following is a more detailed description of MQRA I to MQRA V.

### 6.2.3. MQRA I: 16PF PRIMARIES: A, C, L, Q2, Q3, A-TRAIT

In this first survey-analysis a Goodness of Fit of 86,7% was obtained.

The fact that only seven variables - significantly - contributed to approximately 90% of the overall fit (78,1%) characterized this analysis.

The twenty insignificant contributor-variables very obviously levelled the overall significance of the equation out to a fairly low level.

Extreme distortions in contribution-significance occured: the crossproduct of L x A-TRAIT, contributing 55% to the overall fit, plummeted from an initial F-Ratio on entering the equation of 61,24 to a barely significant 1,99 and so did the Crossproduct of Q2 x Q3: It dropped from a highly significant 13,8 to a final - unsignificant - 0,9.

The experienced levelling effect seems to be mainly due to the fact that this analysis is probably testing the limits of the method by introducing a number of variables more than 50% of the total number of observations.

The algorithm used, however, combines the elimination-procedure with the stepwise decision of including or excluding variables. The application of the proper significance-filters should therefore overcome the distorting effect of the high number of variables.

### 6.2.4. MQRA II: 16PF-PRIMARIES: A,C,L,Q2,Q3, A-TRAIT

Only five variables entered the final equation. These five variables, however, are highly significant and a fairly high percentage fit could be achieved: 77,0079%.

This is only 9,6425% less than the equation with all 27 variables achieved, and a mere 5,4359% less than the equation obtained in MLRA 111.

Included variables are:

"Crossproduct Alaxia - A-TRAIT", which contributed 55% to the overall fit. The coefficient is slightly greater than one, which indicates a rather "pure" contribution of the score-products. The sign of the coefficient is negative, hence low-scores in "Alaxia" and "Trait-Anxiety" lead to a high performance - score on the simulator.

This corresponds with the findings for linear terms only (MLRA 111), where both "ALAXIA" and "A-TRAIT" showed negative coefficients.

The next variable in the rank order of significance is the quadratic term of 16PF-Q2, i.e. "SELF-SUFFICIENCY". Its coefficient is also only slightly greater than one and positive, i.e. high-scores contribute most to a good performance-score.

The linear term of 16PF-Q3, "SELF-CONCEPT CONTROL" also has a positive coefficient, which makes high-scores in this variable conducive to good simulator-performance.

The high numerical value of the coefficient further suggests that already low scores in Q3 may contribute markedly.

The crossproducts of Q2 and Q3 as well as A and C are also included in the equation.

The analysis of variables in rank order of their contribution to Goodness of Fit showed the following.

| STEP NO. | VARIABLE | CONTRIBUTION TO GOODN/FIT | GOODN/OF FIT OF EQUATION |
|---|---|---|---|
| 1 | CRP: ALAXIA x A-TRAIT | 55,0511 | 55,0511 |
| 2 | CRP: GROUP ADH x SELF CONC/C | 9,5109 | 64,9562 |
| 3 | CRP: SIZO/CYCLO x EGO STRENGTH | 3,9392 | 68,8954 |
| (4) | (CRP: EGO STRENGTH x ALAXIA) | (1,6760 | (70,5714) |
| 5 | SQUARE: GROUP ADHERENCE | 1,5995 | 72,1709 |
| 6 | SELF CONCEPT CONTROL | 5,1903 | 77,3612 |
| 7 | DELETION OF VARIABLE: CRP: EGO STRENGTH x ALAXIA | 0,3533 | 77,0079 |

The CRP: 16PF-C/16PF-L was taken in with a F-Ratio of 2,677. The addition of square term 16PF-Q2 increased the ratio to 2,903, the inclusion of 16PF-Q3 (linear term) caused the ratio to drop to 0,7021, well below the minimum F-level.

All six variables are represented in the final equation in cross-products. Group Adherence appears in the quadratic transformation, only Self-Concept-Control is included as the linear term.

The high significance together with the relatively high overall-fit achieved indicates a fairly stringent discriminatory quality of the quadratic transformation.

The rank order of contribution follows quite closely the rank order found for the linear terms. Additional emphasis is placed on factors 16PF-Q2 and 16PF-Q3.

### 6.2.5. MQRA III: 16-PF PRIMARIES A,C,Q2 and 16-PF PRIMARIES L,Q3, A-TRAIT (STAI)

To enable a further distinction of variable-importance, the set of six basic variables was divided into two subsets for further analysis. These subsets were:

1st subset

16-PF A (SIZO/CYCLOTHYMIA)
16-PF C (EGO STRENGTH)
16-PF Q2 (GROUP ADHERENCE/SELF SUFFICIENCY)

2nd subset

16-PF L (ALAXIA/PROTENSION)
16-PF Q3 (LOW/HIGH SELF CONCEPT CONTROL)
A-TRAIT (STAI)

Since only a first survey was intended, the F-Levels to enter/leave were set to ZERO in both runs.

The analysis of the first subset showed a comparatively low overall Goodness of Fit of the obtained equation: a mere 30,4% was achieved.

16PF - primary A proved to be the most significant contributor, being represented in the square term and both crossproducts. Q2 and C were only included in crossproduct terms.

The low fit is also reflected in the relatively high variances of the coefficient-estimates: the confidence interval for the coefficient includes zero for six variables. Only the three most significant variables (SQU:A, CRP: A x Q2, CRP:A xC) show a coefficient of variation less than 100%.

The insignificance of Q2 in this analysis is slightly surprising, especially after MQRA II had included Q2 both in the square term and in the crossproduct Q2 x Q3.

A possible explanation could be that A and C were represented in Crossproduct form in MQRA II, thus indicating a strong interrelation, in which A seems to dominate. This, together with the levelling effect caused by the inclusion of insignificant terms might have suppressed a possible influence of Q2.

An indication of the validity of this explanation can be seen in the fact that Q2 (square term) entered the equation in step 2 with a fit-contribution of 7,5% and an F-ratio of 4,750. The successive inclusion of non-significant variables then caused its F-ratio to fall to a final insignificant 0,5287.

The analysis of variables in rank-order of fit-contribution showed the following:

| STEP | VARIABLE | | CONTRIBUTION TO G/F% | G/F OF SUBEQUATION |
|---|---|---|---|---|
| 1 | CRP: | A x C | 15,3806 | 15,3806 |
| 2 | SQU: | Q2 | 7,4782 | 22,8588 |
| 3 | SQU: | A | 1,5964 | 24,4552 |
| 4 | CRP: | A x Q2 | 4,0218 | 28,4770 |
| 5 | LIN: | A | 0,8222 | 29,2992 |
| 6 | LIN: | C | 0,7777 | 30,0769 |

The other 3 variables could increase the Goodness of Fit by only 0,3432% to 30,4201%. This is equivalent to an average variable contribution of 0,1144%.

The fitting of the quadratic model including the second subset showed a good fit with 63,6594%.

The significant variables in the equation were (in order of significance)

- Crossproduct L x A-TRAIT
- Square term of Q3
- Square term of L

Excessive variance of coefficients of insignificant variables (i.e. including zero in the confidence interval) was experienced in this analysis too.

The stepwise induction of variables into the equation followed the above rank order of final significance, thus indicating a 'genuine' rather than a spurious significance:

| STEP | VARIABLE | | CONTRIBUTION TO G/F% | G/F% OF SUB-EQUATION |
|---|---|---|---|---|
| 1 | CRP: | L x A-TRAIT | 55,0511 | 55,0511 |
| 2 | SQU: | Q3 | 6,5693 | 61,6204 |
| 3 | SQU: | L | 0,2386 | 61,8590 |

The other six variables increased the overall Goodness of fit only marginally by 1,8004% to a final 63,6594%. This represents an average fit-contribution of 0,3001%.

The main contributor, the crossproduct L x A-TRAIT, can be considered as a relatively 'pure' variable, as a check on correlations revealed: Both linear and square terms are virtually uncorrelated with coefficients not greater than 0,06. The intercorrelations of the crossproducts with its components in linear and square form are - expectedly - higher with 0,6 to L and 0,8 to A, which may indicate increased importance of A-TRAIT by itself.

### 6.2.6. MQRA IV: 16-PF PRIMARIES L, Q2, Q3, A-TRAIT (STAI)

Although Q2 did not contribute significantly in the analysis of subset 1 in MQRA III, on account of the strength shown in MQRA II, it was included in this analysis.

The first survey of significance (both F-levels set to ZERO) showed a high Goodness of Fit with 77,0299%.

The inclusion of insignificant variables brought the expected leveling effect.

Despite this artificial balance, however, significance seemed to spread nearly equally over all variables included in this subset. The relative homogeneity of this combination of variables seems to be further underlined by the fact that crossproducts dominate amongst the more significant variables.

This predominant role of crossproducts was confirmed as the analysis was repeated with the appropriate F-level-filter to induce only significant variables.

Only two variables were included in the final equation;

- crossproduct L x A-TRAIT
- crossproduct Q2 x Q3

The achieved Goodness of Fit was 64,9562% - only a mere 17,5% less than the linear fit derived from eleven variables achieved.

Both variables are highly significant with relatively stable coefficients. A scrutiny of the residuals showed a slight positive slope of the band - this model shows the same tendency to overestimate high scores and underestimate low scores as the linear equation.

## 6.3. RESPONSE SURFACE ANALYSIS (RSA)

### 6.3.1. INTRODUCTION

It was felt that the dramatic reduction of variables in the quadratic model, together with the high percentage of fit, could not be excepted without further analysis.

Response Surface Analysis was chosen as the main tool for this analysis.

The main objectives for this further investigation were:

- To explore in depth the interrelations between the variables included in the model and the connex of model and predicted response.
- to determine the existence of optimum conditions.
- to confirm if the fitting is genuine, i.e. if the underlying 'true' relation between the included variables can in fact be best described with a quadratic model, or if the high fit was a mere 'arithmetical' artefact.

  If there is a 'true' underlying second order relation then it can be expected that the system of contour-curves (the 'response surface', RS) has its centre within or very near the feasible region (Davies, 1968; Box 1960). The curves produced by a quadratic model are conics, i.e. have a strictly defined vertex.

There is some argument in the literature, whether a final quadratic model should have a balanced form. (DAVIES, 1968, Box 1960, BOX & DRAPER 1969).

This means, that despite certain individual terms having been discarded by the regression algorithm as insignificant, the final equation should always include a complete set of all terms concerned: if a crossproduct remains, both linear and square terms should be included; if square terms remain, than crossproducts should also appear in the final model, etc.

The disadvantages of an unbalanced model appear to be:

- the supression of a non-significant linear term in one of the variables of a quadratic model might result in the implication that the vertex of the hyperplane concerned occurs at the origin of that variable, which - depending on the nature of the variable - can be an artefact.

- the inclusion of interaction terms only might result in a degree of symmetry of the final model which is probably spurious.

The advantage of an unbalanced model is, however, that the confidence limits of the predictions are kept to a minimum.

It was decided to include solely the unbalanced equations in the RSA.

The reasons for this decision were:

- having the vertex of the resulting conic correspond with the origin of the variables concerned can be a perfectly valid result. Since the test-scores have not been scaled in any way, the origin (i.e. a test-score of zero) is a 'true' value and not an arbitrarily chosen working origin.

- The argument of a probable 'spurious degree of symmetry' is not really applicable to this analysis. What it means is that successive layers of of contour-curves might be artificially brought into a position of concentric vertices, whereby the 'true' surface might show a skew centre-line of vertices, thus showing different degrees of slope in different sections of the RS (whereas concentric vertices result in a constant slope in all sections of the RS)

  This is of importance only in an environment of continuous variables which can be set by the experimenter at his sole discretion, e.g. to approach an optimum region via the path of steepest ascent of the RS.

  This is not the case in this analysis: the variables are discrete and cannot be influenced by the experimenter.

- a scrutiny of the 'balanced' model, i.e. the equation containing all variables, showed that due to the excessive variability of coefficients of insignificant variables, the resulting picture of the RS would be extremely distorted. And principally: to analyse a hyperplane, which, by definition, can have virtually any slope, with the present one just being the one that happened to suggest itself by the data, seems a somewhat futile exercise.

  In terms of the RS created, the levelling effect observed in the balanced models produced a singular pattern for all combinations of variables: flat parabolas (indicating a near-linear stationary ridge) with positive slope, consistently and indiscriminately showing high test scores to produce high responses.

The sets of variables included in the RSA were:

RSA I: 16-PF A, C, L, Q2, Q3 and A-TRAIT (STAI)
RSA II: 16-PF L, Q2, Q3 and A-TRAIT (STAI)

The analysis was concluded in two steps. The first step restricted the RS to the feasible region, i.e. variable-values from 1 to 10 only. To obtain a picture of the more complete structure of RS, the boundaries of the investigated region were extended to include -10 to +20 for variable values in the second step.

The following nomenclature is being used:

FR - Feasible Region
RS - Response surface
RL - Response levels ('contour heights') :

A = 25 (i.e. simulator score)
B = 50
C = 75
D = 100
E = 125
F = 150
G = 175
H = 200
I = 225
J = 250

Direction of Slopes:

NW - towards top-left-hand-corner;
opt. response: high ordinate-variable
low abscissa - variable

NE - towards top-right-hand corner;
opt. response: high ordinate - variable
high abscissa - variable

SE - towards bottom - right-hand-cover;
opt. response: low ordinate - variable.
high abscissa - variable.

SW - towards bottom - left-hand-corner
opt. response: low ordinate- variable.
low abscissa - variable.

### 6.3.2. SUMMARY OF FINDINGS

This analysis of the response surfaces yielded by the quadratic models was carried out to determine and explore the relevance of strengths of the personality-variables to the expected performance level in more depth.

In RSA I the contour diagrams of the model fitted in MQRA II were investigated.

The variables 16PF-A and 16PF-C were found to be of importance mainly for higher levels of performance. The interaction of A-TRAIT and 16PF-L spreads over a broader spectrum of performance levels. This spectrum, however, covers only the area of mediocre performance.

16PF-Q2 and 16PF-Q3 was found to be the only combination of variables that produced optimum performance. High scores in Q2 are of more influence than high scores in Q3.

RSA II, carried out on the surfaces yielded by the model developed in MQRA V, confirmed the findings of RSA I, although the importance of the interaction of Q2 and Q3 was found to be more evenly spread between both variables.

### 6.3.3. RSA I: 16-PF PRIMARIES A, C, L, Q2, Q3 and A-TRAIT (STAI) (Unbalanced Model)

Interaction A x C: Only one response level (RL) is manifest in the feasible region (FR). Its curve indicates that either high A with only 50% of C or vice versa leads to a upper-region simulator score.

Extending the boundaries, it was found that the RS created is a hyperbolic plane with a distinct saddle about G-level. The centre of the system is approximately at the origin of both variables. The low levels are sloped NW/SE, the ascending slope runs NE/SW.

The RS obtained seems to indicate that both variables come to importance at high performance level only.

Interaction L x A-TRAIT: four contours are crossing the FR: C to G. The slope is to SW and flattening out with increasing RL.

Extending the RS beyond the FR, a hyperbolic plane is found, again centred at the origin of both variables and with a saddle at G-level. The axes of the system are nearly congruent with the axes found for A x C, the slopes, however, are inversed: Low-RL's are on NE/SW, higher responses ascend along NW/SE.

In accordance with the magnitude and sign of the coefficients for L x A-TRAIT (around 1,0 and negative) the RS indicates clearly increasing response with decreasing variable- values.

The range of manifest RL's seems to indicate that both variables are of importance rather in the low-performance-region.

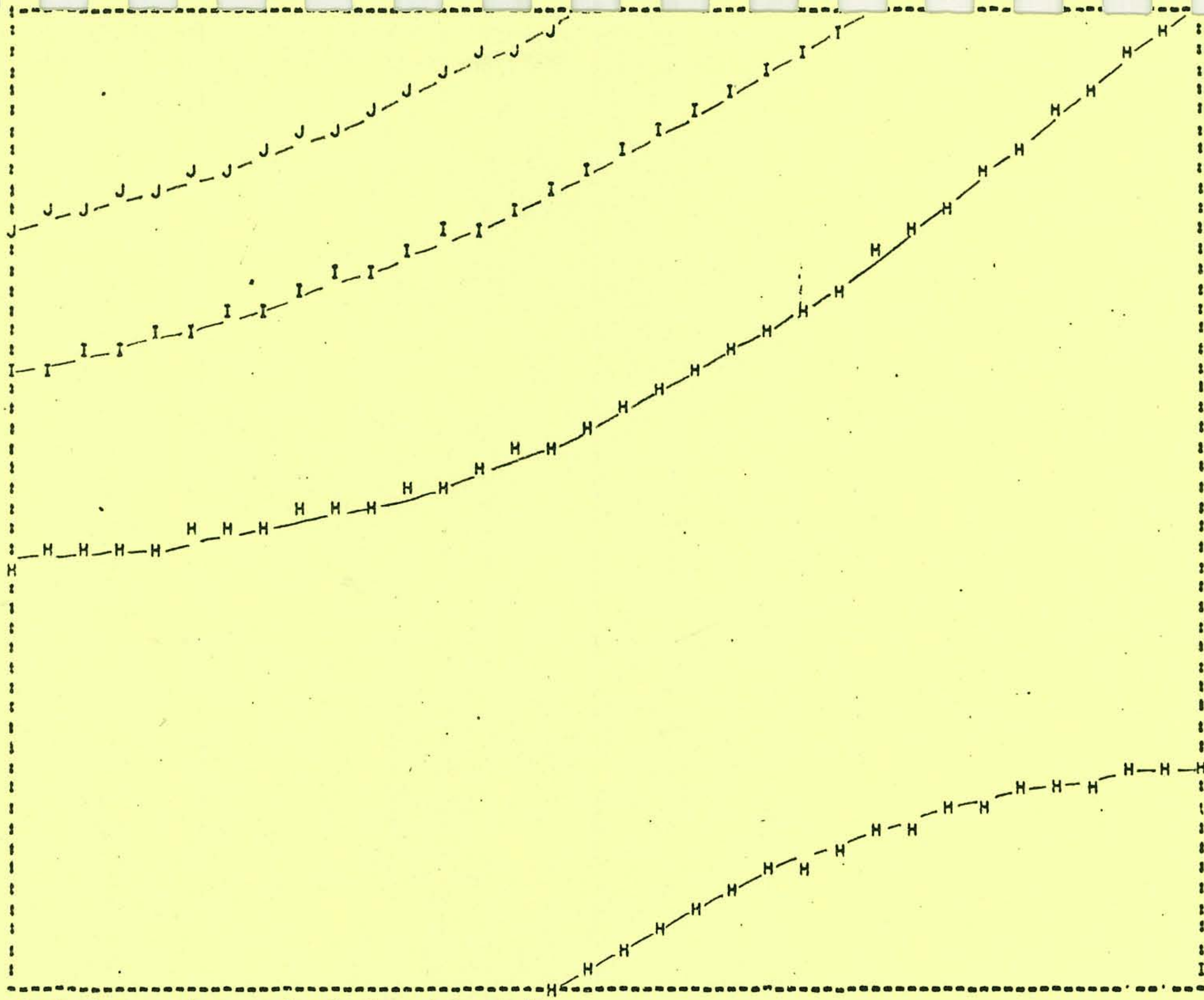
The near perfect symmetry of the conic system is clearly a result of the fact that both variable-combinations were represented in the model in crossproduct form only.

Interaction Q2 x Q3: The obtained hyperplane within the FR is obviously the saddle of a hyperbolic surface. Only high RL's are represented: H to J, and the high level slope runs NW/SE. The region SW/NE appears as a flattened saddle about, or just below H-level.

In exceeding the FR-boundaries, the RS becomes a longstretched hyperbolic plane, with the longitudinal axis in NE/SW (descending RL's), and the axis of ascending RL's at right angles to it. The saddle, around H-level, covers quite a large area, with steep inclines towards I and J in NW, resp. SE.

The specific character of the hyperplane, expecially the dominating flat saddle at high RL seems to indicate that virtually all combinations of Q2 and Q3 would predict high performance. Q2, due to the J-contour in NW, would be the variable, whose high-score carries more weight. This is somehow underlined by the fact that Q2 was introduced into the model as square term, Q3 as linear term, and their crossproduct had a negative coefficient (as a levelling effect this probably caused the flat saddle).

Generally therefore, any combinations of Q2 and Q3 should yield a good performance-level. The optimum however could be seen in a combination of high Q2 and not too low Q3.

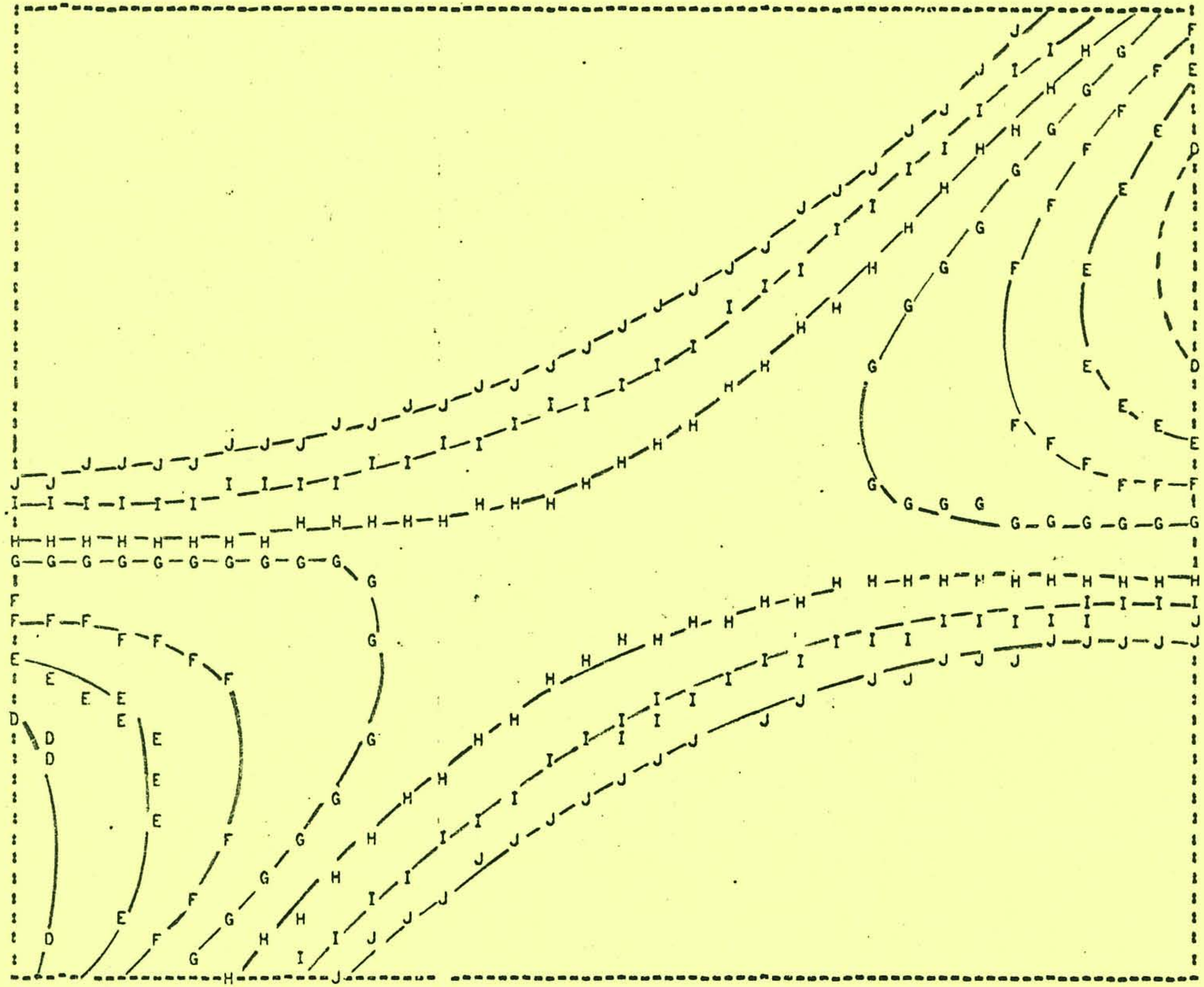


RESPONSE SURFACE OF VARIABLE 4 ON THE Y-AXIS
AND VARIABLE 5 ON THE X-AXIS

KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):

| SYMBOLS: | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| RESP.L.: | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 |

Fig. 8: 16PF-Q2 (Var. 4) versus 16PF-Q3 (Var. 5) in the FS



RESPONSE SURFACE OF VARIABLE 4 ON THE Y-AXIS
AND VARIABLE 5 ON THE X-AXIS

KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):

| SYMBOLS: | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| RESP.L.: | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 |

Fig. 9: 16PF-Q2 (Var. 4) versus 16PF-Q3 (Var. 5) in the extended FS

Since A-TRAIT was included into the model in crossproduct with L only, the RS of Q2 x A-TRAIT and Q3 x A-TRAIT is meaningless.

## 6.3.4. RSA II: 16-PF PRIMARIES L, Q2, Q3 and A-TRAIT

(Unbalanced model)

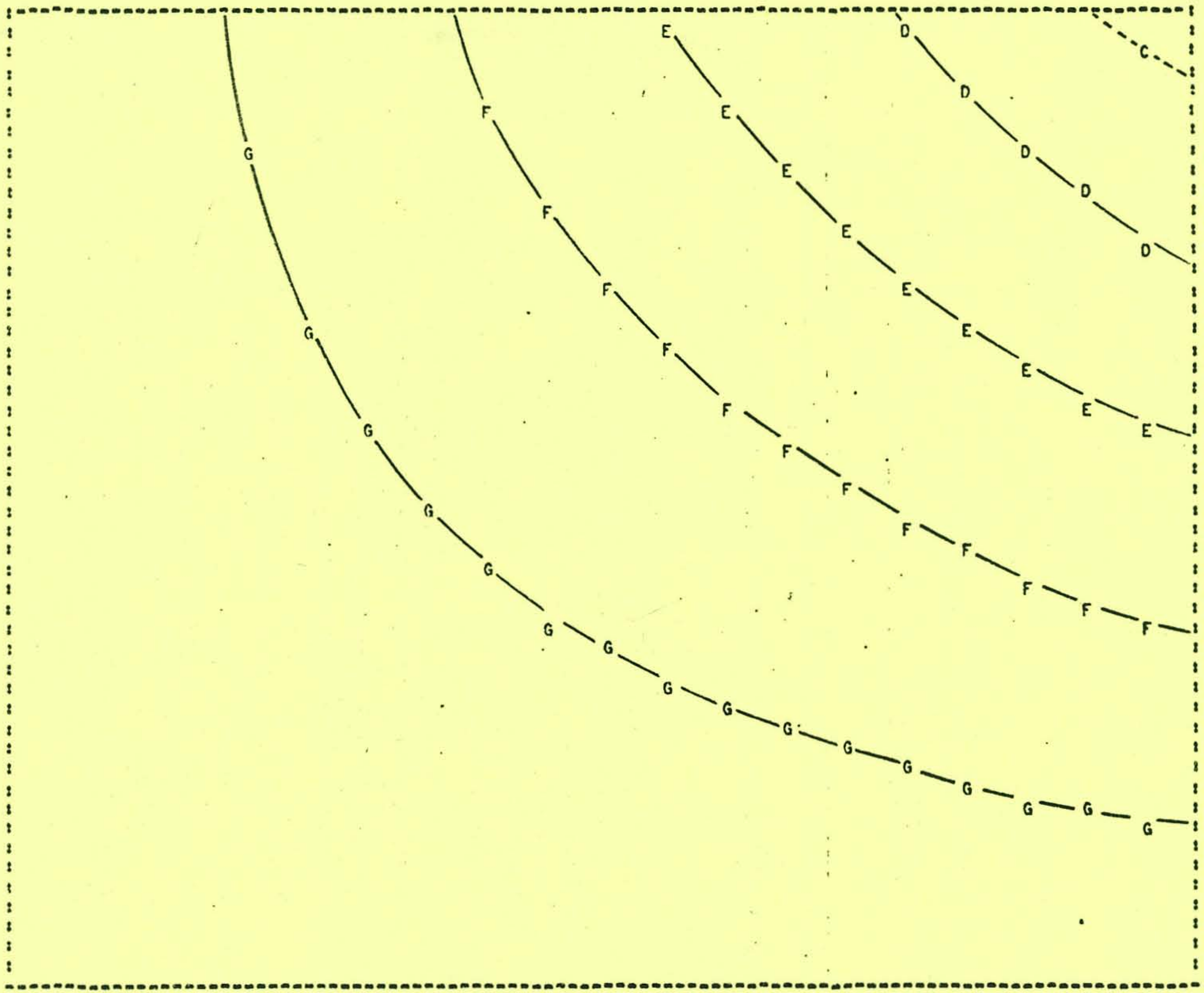
Interaction L x A-TRAIT: The RS contains the RL-range from C up to G, the slope is SW. The contour heights are equally spaced. The FR covers a higher range of RL's than the same interaction in RSA I, but the actual slope of the hyperplane seem to be virtually the same.

This is confirmed by the extension of the RS beyond the FR to include a range from -10 to +20. The resulting surface is a hyperbolic plane with the centre of the system approximately coinciding with the origin of both variables. The low-level slope is NE/SW, the high-level axis runs through NW/SE. Ascents and descents seem to be rather steep, with a high saddle point at H-level.

Interaction Q2 x Q3: Only three RL's (H to J) lie within the FR. The slope is NE, with the ascent steepening towards the optimum contour-line. The extended RS shows again a system of hyperbolics, with a saddle (H) coinciding roughly with the centre of the system in the origin of both variables. The descending slope is NW/SE, with the ascending axis joining at right angles.

The high degree of symmetry of both systems is again explained by the fact that no linear or square terms were included in the model.

While the RS of L x A-TRAIT remained unchanged against RSAI, the interaction of Q2 x Q3 in this model points unmistakably in the direction of high performance due to high variable values in both variables. The optimum contour, however, also recognises 50% values in both variables, provided the other is at maximum.

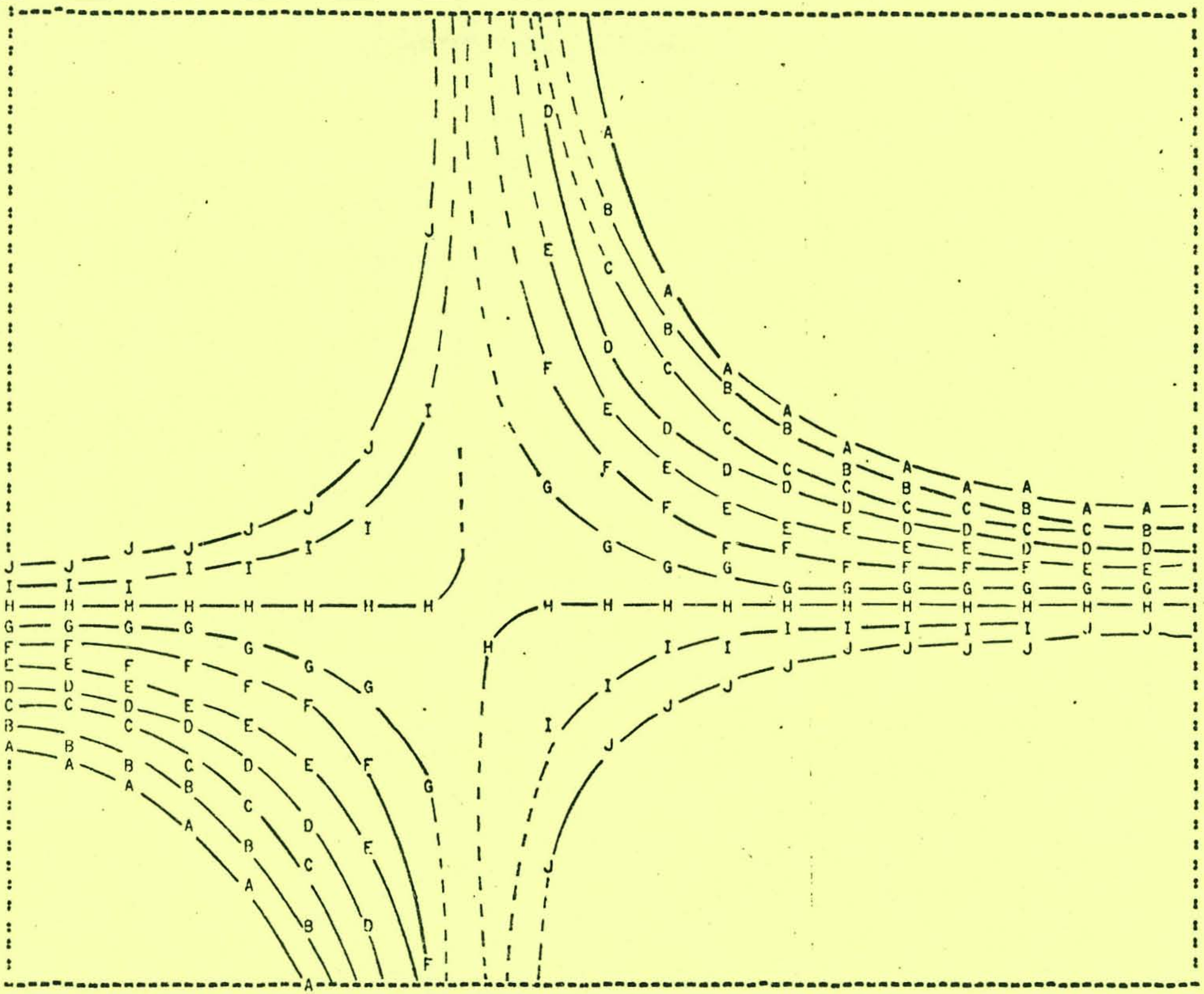



RESPONSE SURFACE OF VARIABLE 1 ON THE Y-AXIS
AND VARIABLE 4 ON THE X-AXIS

KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):

| SYMBOLS: | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| RESP.L.: | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 |

Fig. 10: 16PF-L (Var. 1) versus A-Trait (Var. 4) in the FS

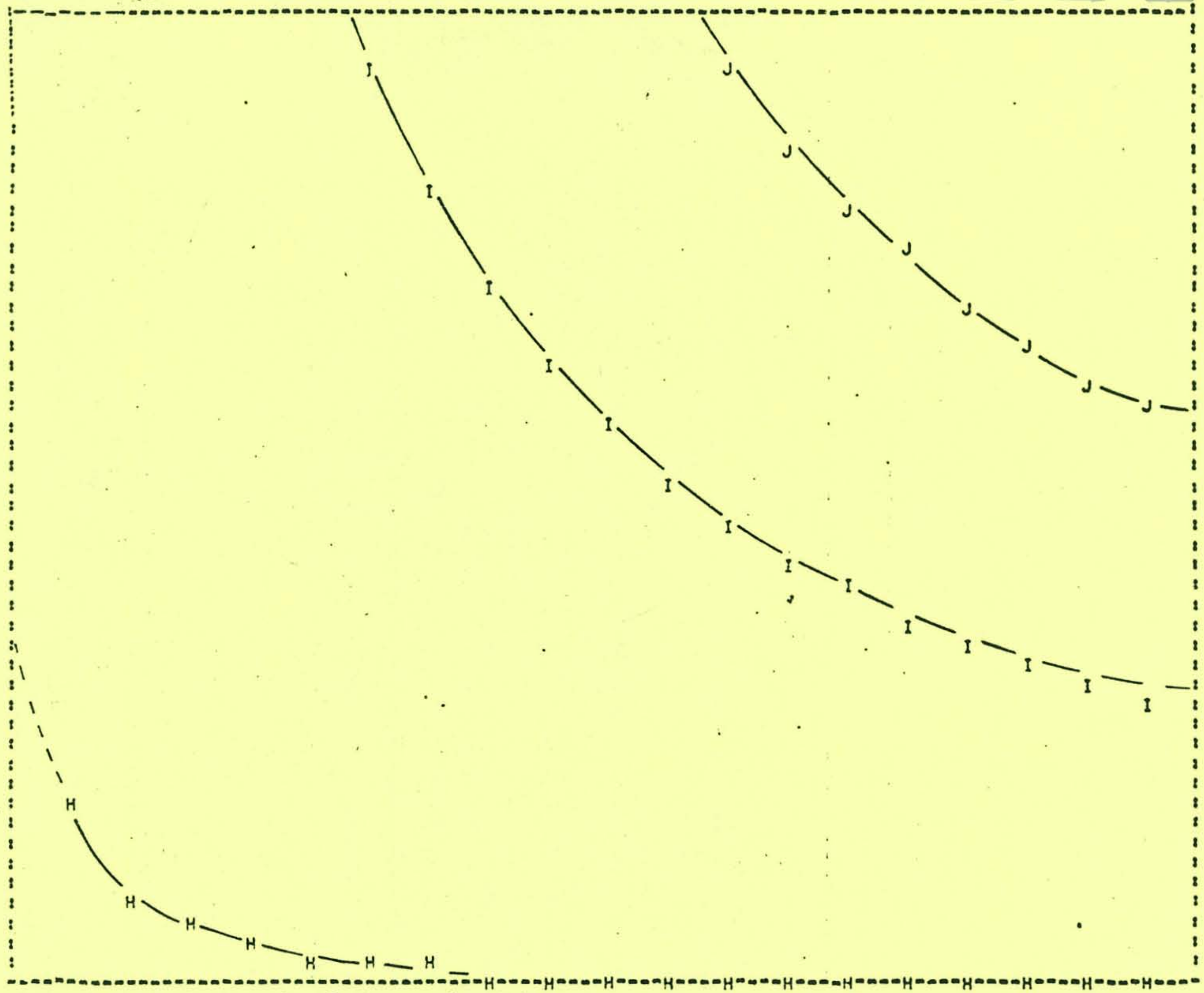


RESPONSE SURFACE OF VARIABLE 1 ON THE Y-AXIS
AND VARIABLE 4 ON THE X-AXIS

KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):

| SYMBOLS: | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| RESP.L.: | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 |

Fig. 11: 16PF-L (Var. 1) versus A-Trait (Var. 4) in the extended FS



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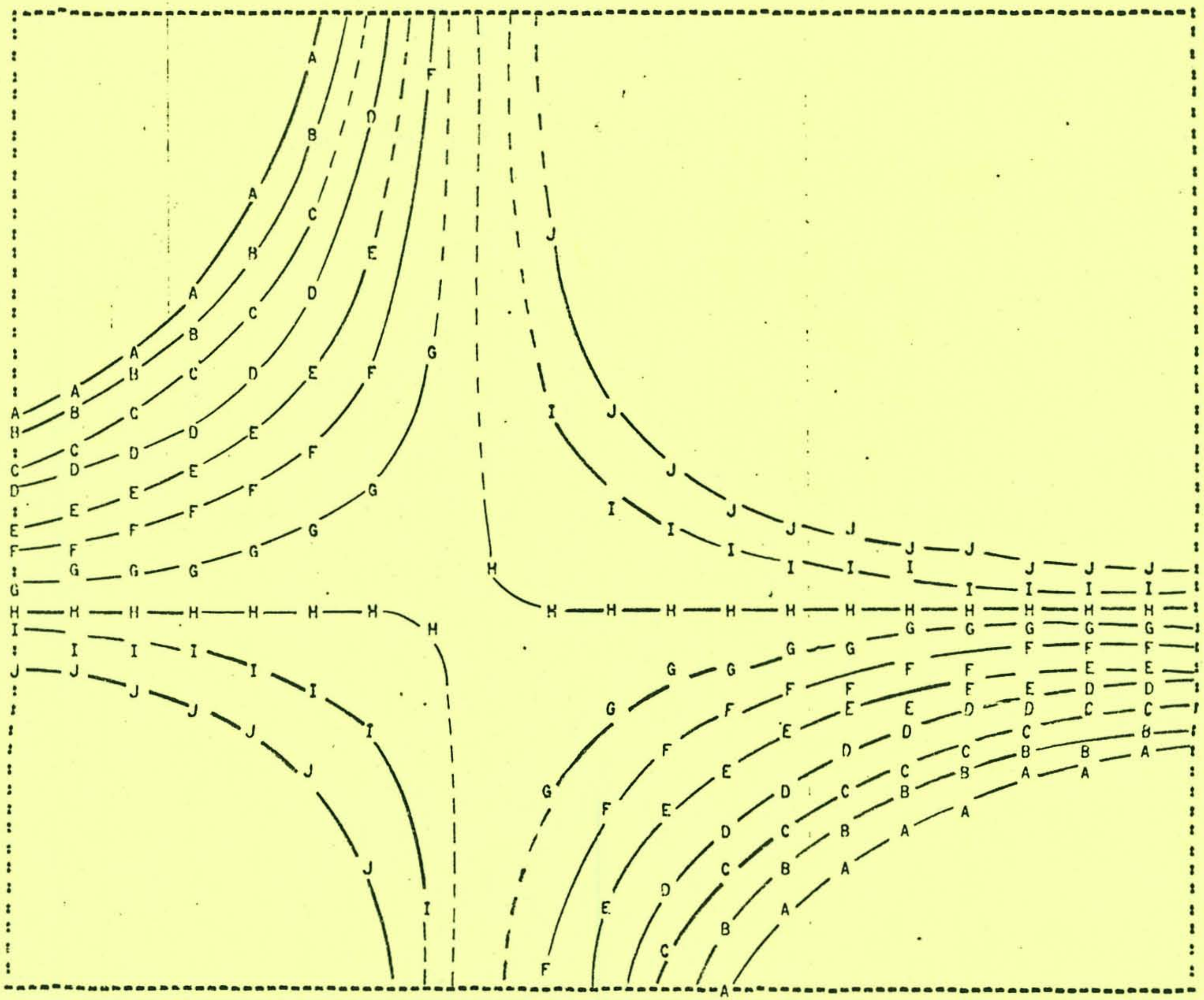
RESPONSE SURFACE OF VARIABLE  2 ON THE Y-AXIS
             AND VARIABLE  3 ON THE X-AXIS

KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):
SYMBOLS:A    B    C    D    E    F    G    H    I    J
RESP.L.:  25   50   75  100  125  150  175  200  225  250
```

Fig. 12: 16PF-Q2 (Var. 2) versus 16PF-Q3 (Var. 3) in the FS



RESPONSE SURFACE OF VARIABLE 2 ON THE Y-AXIS
AND VARIABLE 3 ON THE X-AXIS

KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS: | A | B | C | D | E | F | G | H | I | J |
| RESP.L.: | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 |

Fig. 13: 16PF-Q2 (Var. 2) versus 16PF-Q3 (Var. 3) in the extended FS

A comparison of the extended RS's shows that the RS yielded in this model is rotated by approximately 90° against the conic system obtained in the previous analysis.

Although, due to the dominant saddle area in the hyperplane of RSA II, which saturated virtually all of the FR with high-level response, there is no direct contradiction in the interpretation of the contour-systems, it was decided to disregard the RS of Q2 x Q3 obtained in this analysis in any further interpretation. The corresponding RS of RSA I, yielded by a model which also includes linear and square terms, is regarded as more valid.

## 7. SUMMARY AND CONCLUSION

The Multiple Linear Regression Analysis has yielded a prediction equation with a reasonable Goodness of Fit and, furthermore, a fairly comprehensive set of psychologically plausible personality factors conducive to good operational performance under stress conditions could be derived.

The attempt to fit a second-order-model to the observational data did not prove successful with respect to predictive qualities. It was felt that the relatively small sample in conjunction with the drastic reduction of predictor variables could easily represent "too much coincidence", i.e. there might be a considerable probability that an unmeasurable amount of value configuration particular to the sample and amplified by the quadratic transformation influenced the outcome beyond the boundaries of routine significance considerations.

This suspicion was further underlined by the obtained RS's, which tended to be for one rather meagre and secondly possessed a fairly high degree of obviously artificial symmetry. Thirdly, the dominating form of hyperplane found turned out to be a saddle-plane, which is basically the least conclusive form of RS possible.

It was therefore decided to accept the model yielded by MLRA III as the main predictive link obtained from this project.

This linear model suggested a syndrome of personality-factors conducive to good operational performance which can be characterised by the following descriptive factor-clusters:

- EGO STABILITY CONTROL (low A-TRAIT, C+, L-, Q3)

- SELF ORIENTATION (Q2+, G-, I-)

- HYPER ACTIVATION-POTENTIAL (Q4+, high A-STATE) and, or minor importance

- CYCLOTHYMIA (A+)

- LOW INTELLIGENCE (RAVEN PM)

Using, and merging, CATELL's verbalizations of personality factors, the following - first - picture of the "emergency resistant operator" (in general terms) emerges:

He can be socially precise, and he tries to live up to his self-image. This, combined with the tendency to be rather resolute and being basically not an anxious person outlines a personality mainly characterised by a-neuroticism. Adding further to this impression is a certain capacity for emotional control with particular reference to exercising pragmatism where the realities of a situation may demand it.

Normally he is easy going and shows a fair degree of participating relaxedness.

The "rough edges" of this personality come through in a strong sense of self-reliance, expressed in a pronounced "no-nonsense" attitude. There is further a strong tendency to evade obligations and rules, the more when they collide with his own ideas.
Also "underneath" the generally controlled, relaxed balance and the only thinly covered strong egocentrism, there is a moment of "hidden" tension and irritability, combined with a certain ability for arriving fairly rapidly at a relatively high level of (basically anxious) alertness in situations of a threatening character.
He need not be intelligent.

Although the findings of the MQRA and the RSA did not directly contribute to the main objective of this project, both methods proved very valuable as diagnostic tools, i.e. both methods of further analysis helped considerably in obtaining more insight into the structure of the above syndrome.

The findings of the Quadratic Regression principally underlined the outlines of the above syndrome.

In addition the component of EGO STABILITY CONTROL was clearly emphasised and in its infrastructure the interaction of L- and A-TRAIT was assigned a dominating weight above the other two factors indicated by the linear model.

The importance that the interaction of Q2 and Q3 was given by the MQRA results in a slight shift of character of the cluster SELF ORIENTATION: Under the aspect of interacting with Q3-, the predominantly positive character of self-sufficiency, rather strengthened by an element of ego-centrism, could now be seen as one solution of the "undisciplined self-conflict" that Q3 suggests.

The Response Surface Analysis served mainly to differentiate between the effects that the clusters have on performance levels, and further added to the understanding of the infrastructure of the syndrome.

The interaction of relaxedness and low anxiety(L x A-TRAIT) was again confirmed to be the basic cluster conducive to good operational performance. The response surface yielded by these two variables covered the largest section of response levels of all other variables.

Q2 and Q3, the two main components of the cluster SELF ORIENTATION, were found to be mainly indicators of the higher performance levels: interestingly, the RS suggested a combination of low Q3 and high Q2 as a set-variation conducive to favourable performance.
The response surface created by A (Cyclothymia) and C (Ego Strength) indicated also some importance in the upper performance range only.

(Q4 and A-STATE were not included in the variables selected for the MQRA and RSA)

With respect to the dimensions Performance Level, Variable Influence and Score-Range, the findings of the MQRA and RSA can be summarized as follows:

- L and A-TRAIT, both low-score, are the broad foundation of the syndrome - of relatively high influence, but only for the low-to-medium-level performance range.

- The interaction of A and C, both in the above-average-score range, is interpreted as the enhancement of L x A-TRAIT (C+ is part of the cluster EGO STABILITY CONTROL) which effects the upper performance levels. Its importance is classed as minor to medium.

- Q2 x Q3, with Q2+ and Q3 rather in the low score area, are of minor importance as variables, but, since their syndrome seems to play a major part in the actual capacity of stress-tolerance, are predominantly effective in the medium-to-high performance class only.

Figure 14 is a graphic approximation of the assumed influence-spaces of the above variable combinations.

Incorporating the additional findings obtained by the MQRA and the RSA, the original syndrome as derived from the linear model can be reduced to three main clusters with supporting sybsyndromes.

The main and basic set of personality factors needed to resist the operational stress in this experiment seems to be EGO STABILITY CONTROL, now defined as being basically consistent of low score L and low A-TRAIT. The extrovert element in A+ is to be seen as a strengthening agent to L-, as the overall emotional stability represented in C+ reinforces low anxiety. The interaction of A+ and C+ then would form the presupposition to achieve higher performance levels.

The secondary condition needed to capacitate stress-resistance (at least in this experiment) is described as SELF ORIENTATION. It is based mainly on the interaction of Q2 and Q3, whereby the combination Q2+/Q3- seems to preferable. Due to this particular configuration, the combination may be termed "unstable self-sufficiency", implying that Q2+ is at least partly a compensation for the low degree of social integration represented by Q3-. The supporting structure of the syndrome may be found in the subsyndrome of Ego-Centrism, represented by G- and I-.

The cluster termed HYPERACTIVATION POTENTIAL, consisting of Q4+ and high A-STATE, stays unchanged, since neither of its variables were included in the MQRA or RSA.

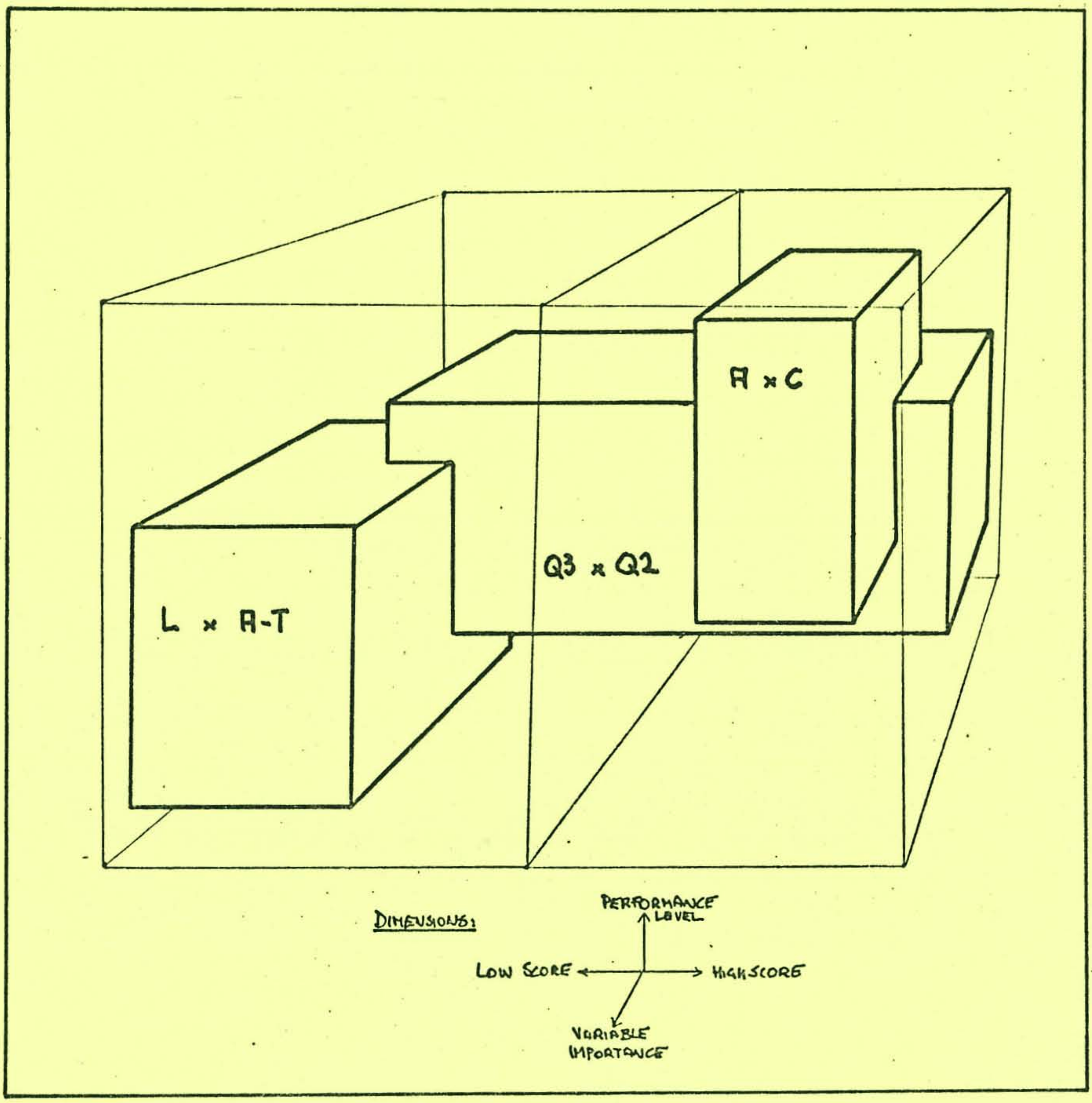



Fig.14. Graphic approximation of influence spaces of variable combinations

(Since it could be rightly argued that the fact that a lower degree of Intelligence was found to be conducive to higher performance in this experiment could be mainly due to the simplicity of the simulated operation, Intelligence is not included in this final clustering.)

The conclusions drawn above are - to some degree - supported by other findings in the field of research on performance under stress. DANIELS (1973) in his above cited article on parachutists found A+, C+ and Q2+ of importance in the endurance of stress. BUCKY & SPIELBERGER (1973) in investigating correlates to withdrawal from flight training found an interesting connection between the relative degree of A-STATE and different kinds of "flight training drop outs": a very high degree of A-STATE seemed to lead to voluntary withdrawals (because of 'physical' reasons) and a low degree of State-Anxiety was correlated to failure-drop out. This seems to underline the 'breaking point theory': too high a degree of A-STATE tends to support escape-reactions, while too low a degree of A-STATE represents an insufficient degree of alertness to cope with sudden changes.

The relevance of the cluster of self-orientation is underlined by findings of BIERSNER & RYMAN (1974) in their research on performance-prediction for scuba-divers. They found that sucessful divers are high in Q2, low in Q3 and low in G. (Their term for this syndrome was "asocial").

No support could be found in the literature for the combination of L- and low A-TRAIT.

Due to the fact that in the literature there is only narrow support to be found for the conclusions come to in this project, and considering the small sample this project was based on, it seems only fair to classify the above described findings and derivations as pilot results only, and a guide to future research in this field.

Some recommendations for future research are given in the next section.

## 8. RECOMMENDATIONS FOR FUTURE RESEARCH

If the findings and conclusions in this study should be investigated further, the following list of recommendations may prove helpful:

- To verify the validity of the obtained linear model (in order to determine any inherent weaknesses) in a controlled experiment.

- To use a larger sample to improve the quality of the statistics obtained.

- To use a sufficiently large sample to be able to construct a Central Composite Design of the experiment in order to deploy the full capacity of Response Surface Methodology.

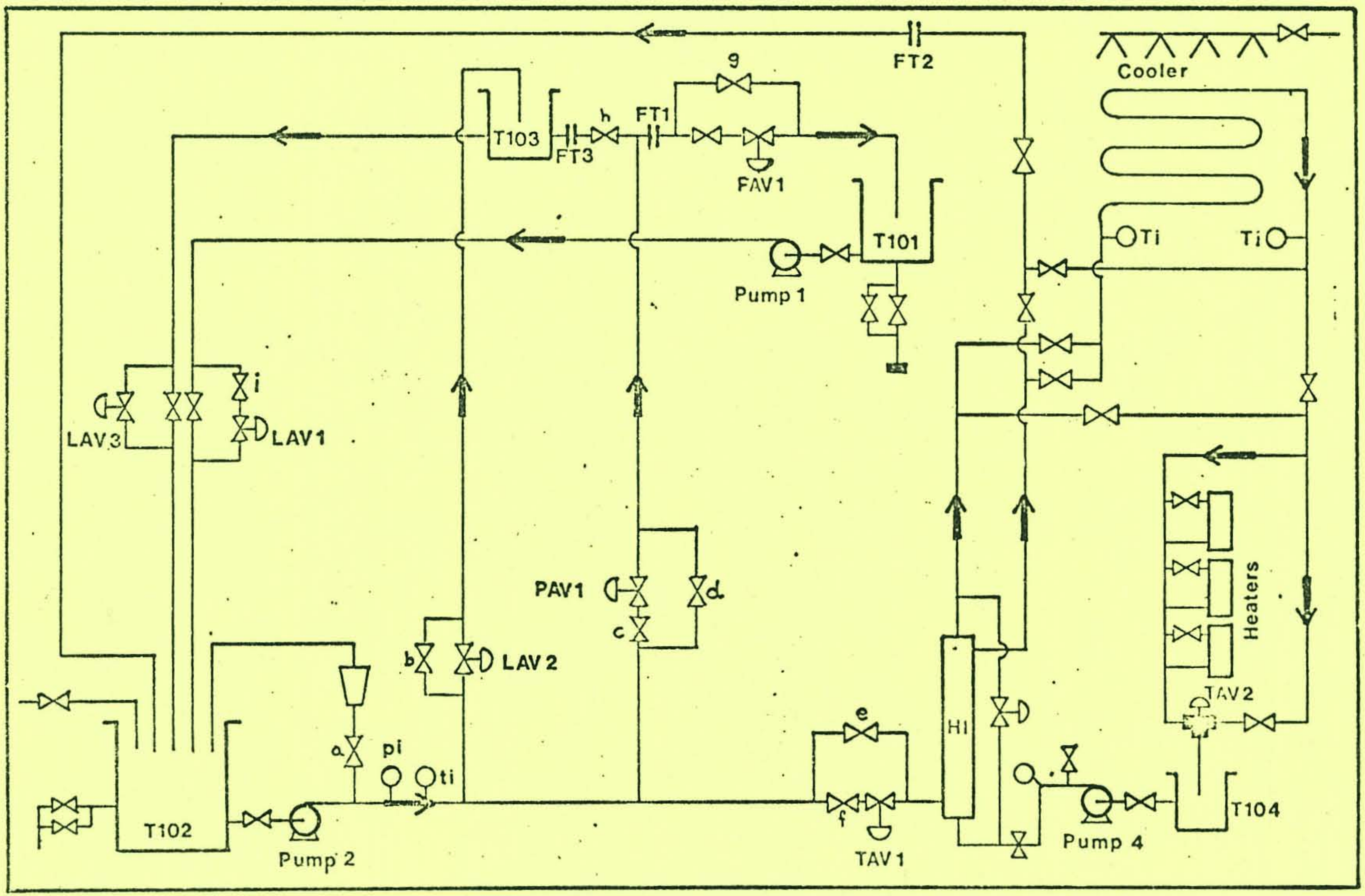
- To use specialised scales to measure the personality factors indicated in this project.

- To use sophisticated scaling methods in trying to fit a higher-order-model.

- To develop a better method for measuring performance in the task.

# A P P E N D I C E S

APPENDIX A




A.1. Flow diagram of the Chemical Plant Simulator at AECI/Umbogintwini Factory

## A.2. Description of Simulator-Task

The following instruction was issued (verbally) to the S's:

"You are handed this plant over in perfect running condition. We expect you to hand over the plant to your successor in exactly the same condition. Your shift is 30 min. long. During the shift faults and defects will occur.

You have to fix them all up within the 30 min., which is quite possible if you keep your cool. The clock on the wall gives you the elapsed time, and the training officer will tell you the elapsed time in five minute intervals. He will also keep a score of how you are doing. These are the safety regulations; any violation will bring your score down. If you make a lethal mistake, the experiment will be terminated immediately".

Then followed detailed instructions on what pressure-, flow-rates and tank-level-readings were to be maintained and in which areas of the 'plant' to wear specific safety equipment, e.g. goggles, etc.

The table overleaf shows a detailed breakdown of the standardized series of faulty conditions:

| Time*) | Fault | Indication of Fault | Corrective action |
|---|---|---|---|
| 2 | Pump 2 stopped<br>PAV I inoperable<br>FAV I inoperable | Main circulation comes to a standstill, no flow-readings available | Isolate valves a to f,<br>start up pump,<br>establish bypasses around PAV I, FAV I |
| 8 | PAV I reset<br>FAV I reset<br>LAV II fully open | Pressure rates drop (ALARM),<br>flow rates increase (ALARM),<br>level in T103 increases (ALARM) | Open LAV III and establish bypass,<br>isolate valve h,<br>close LAV II - adjust flow, pressure/levels |
| 11 | Pump I stopped<br>LAV II inoperable | Level in 103 drops (ALARM),<br>level in 101 increases (ALARM) | Adjust flows/levels,<br>open valve h,<br>close bypass around LAV III,<br>adjust LAV III,<br>isolate valve i,<br>Start up pump,<br>adjust LAV I |
| 16 | FAV I inoperable | Level in 101 drops (slowly),<br>pressure increases rapidly (ALARM) | Establish FAV I bypass,<br>adjust flow rates |
| 20 | Pump 2 stopped<br>PAV I inoperable | Level in 103 drops (ALARM),<br>level in 101 drops,<br>level in 102 increases (ALARM) | Isolate valves a to f,<br>start up pump,<br>establish bypass around PAV I,<br>balance and adjust flows |

*) = Legend: See overleaf

Legend: TIME : elapsed time in minutes; at this point in time the fault-conditions were set via a remote-control-console

INDICATION OF FAULT :

where 'ALARM' is mentioned the change in conditions occured so rapidly that on average the appropriate alarm would go off.

The alarms were set to very narrow limits around the levels to be maintained and were set to maximum loudness (siren) and increased flash-rate (visual indication).

APPENDIX B

ORIGINAL DATA MATRIX

| OBS.NO. | PF/A | PF/B | PF/C | PF/E | PF/F | PF/G | PF/H | PF/I | PF/L | PF/M | PF/N | PF/O | P/01 | PFQ2 | P/03 | P/Q4 | STATE | TRAIT | INT. | AGE | EXP. | SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6. | 10. | 4. | 6. | 2. | 6. | 6. | 6. | 6. | 8. | 3. | 6. | 5. | 7. | 7. | 6. | 4. | 5. | 6. | 42. | 0. | 188. |
| 2 | 8. | 8. | 5. | 6. | 8. | 7. | 5. | 3. | 6. | 4. | 4. | 4. | 8. | 4. | 6. | 3. | 5. | 3. | 6. | 26. | 0. | 223. |
| 3 | 8. | 9. | 2. | 5. | 5. | 3. | 4. | 7. | 9. | 6. | 4. | 6. | 2. | 7. | 1. | 9. | 8. | 4. | 6. | 23. | 0. | 169. |
| 4 | 5. | 8. | 5. | 6. | 5. | 4. | 3. | 5. | 10. | 6. | 7. | 6. | 4. | 8. | 3. | 9. | 5. | 2. | 6. | 33. | 4. | 193. |
| 5 | 7. | 8. | 4. | 7. | 8. | 3. | 5. | 7. | 8. | 7. | 4. | 6. | 6. | 5. | 5. | 5. | 7. | 5. | 6. | 21. | 0. | 190. |
| 6 | 6. | 8. | 7. | 8. | 3. | 6. | 7. | 4. | 6. | 3. | 8. | 3. | 9. | 5. | 7. | 4. | 5. | 2. | 7. | 36. | 1. | 195. |
| 7 | 6. | 8. | 4. | 9. | 7. | 3. | 10. | 6. | 6. | 6. | 3. | 7. | 7. | 10. | 3. | 9. | 5. | 4. | 5. | 39. | 15. | 231. |
| 8 | 5. | 8. | 4. | 4. | 3. | 4. | 2. | 5. | 6. | 5. | 3. | 8. | 7. | 8. | 3. | 5. | 7. | 5. | 6. | 39. | 3. | 170. |
| 9 | 5. | 9. | 2. | 4. | 3. | 2. | 3. | 4. | 3. | 5. | 6. | 8. | 5. | 9. | 2. | 7. | 7. | 8. | 8. | 40. | 2. | 187. |
| 10 | 4. | 6. | 8. | 6. | 9. | 7. | 8. | 5. | 5. | 3. | 4. | 6. | 6. | 4. | 5. | 6. | 2. | 3. | 9. | 24. | 0. | 161. |
| 11 | 5. | 8. | 2. | 4. | 3. | 7. | 3. | 5. | 6. | 7. | 7. | 8. | 4. | 8. | 7. | 6. | 4. | 6. | 5. | 29. | 3. | 193. |
| 12 | 5. | 4. | 7. | 6. | 6. | 4. | 7. | 8. | 9. | 5. | 4. | 7. | 3. | 5. | 2. | 8. | 6. | 7. | 5. | 31. | 4. | 138. |
| 13 | 6. | 3. | 8. | 5. | 5. | 4. | 6. | 7. | 8. | 6. | 3. | 6. | 4. | 6. | 4. | 8. | 6. | 6. | 6. | 28. | 3. | 142. |
| 14 | 5. | 3. | 4. | 5. | 6. | 5. | 4. | 7. | 7. | 5. | 5. | 6. | 5. | 5. | 4. | 7. | 6. | 5. | 7. | 22. | 0. | 155. |
| 15 | 6. | 8. | 4. | 3. | 6. | 6. | 2. | 4. | 4. | 5. | 8. | 3. | 7. | 5. | 8. | 2. | 3. | 4. | 7. | 32. | 0. | 228. |
| 16 | 7. | 7. | 3. | 4. | 7. | 8. | 5. | 4. | 3. | 6. | 7. | 4. | 8. | 6. | 8. | 4. | 2. | 3. | 9. | 27. | 3. | 207. |
| 17 | 6. | 6. | 2. | 5. | 6. | 7. | 4. | 5. | 4. | 5. | 7. | 5. | 7. | 7. | 7. | 3. | 6. | 5. | 8. | 23. | 4. | 222. |
| 18 | 5. | 5. | 4. | 6. | 10. | 7. | 7. | 6. | 6. | 6. | 5. | 5. | 3. | 5. | 6. | 6. | 8. | 6. | 4. | 24. | 0. | 174. |
| 19 | 7. | 6. | 7. | 5. | 7. | 2. | 7. | 3. | 9. | 6. | 1. | 5. | 5. | 5. | 7. | 5. | 3. | 1. | 6. | 24. | 0. | 205. |
| 20 | 5. | 9. | 6. | 7. | 7. | 6. | 7. | 8. | 8. | 2. | 6. | 5. | 5. | 4. | 3. | 3. | 5. | 5. | 7. | 21. | 0. | 101. |
| 21 | 5. | 9. | 3. | 9. | 6. | 6. | 3. | 6. | 6. | 4. | 6. | 6. | 3. | 8. | 5. | 5. | 3. | 5. | 6. | 26. | 0. | 165. |
| 22 | 3. | 5. | 4. | 1. | 4. | 4. | 4. | 5. | 2. | 2. | 10. | 5. | 5. | 5. | 9. | 3. | 5. | 5. | 7. | 36. | 3. | 235. |
| 23 | 6. | 4. | 3. | 2. | 2. | 4. | 3. | 7. | 8. | 3. | 7. | 6. | 5. | 7. | 4. | 7. | 7. | 8. | 7. | 24. | 0. | 115. |
| 24 | 6. | 8. | 5. | 7. | 5. | 8. | 7. | 4. | 5. | 4. | 6. | 6. | 6. | 4. | 9. | 5. | 6. | 7. | 8. | 23. | 0. | 196. |
| 25 | 6. | 7. | 4. | 4. | 5. | 3. | 5. | 6. | 6. | 6. | 4. | 8. | 5. | 6. | 3. | 6. | 6. | 7. | 3. | 24. | 3. | 159. |
| 26 | 7. | 7. | 8. | 6. | 6. | 7. | 5. | 1. | 3. | 4. | 9. | 1. | 8. | 9. | 5. | 2. | 2. | 1. | 9. | 26. | 2. | 251. |
| 27 | 7. | 8. | 6. | 4. | 6. | 7. | 6. | 4. | 9. | 4. | 8. | 8. | 5. | 8. | 9. | 6. | 3. | 2. | 7. | 24. | 2. | 231. |
| 28 | 5. | 5. | 5. | 6. | 5. | 6. | 3. | 4. | 9. | 8. | 4. | 8. | 7. | 8. | 4. | 7. | 7. | 7. | 9. | 25. | 1. | 140. |
| 29 | 7. | 7. | 5. | 2. | 4. | 7. | 7. | 5. | 6. | 5. | 8. | 4. | 3. | 5. | 5. | 5. | 4. | 3. | 5. | 37. | 2. | 182. |
| 30 | 7. | 9. | 4. | 6. | 3. | 3. | 1. | 6. | 8. | 5. | 2. | 9. | 6. | 7. | 3. | 10. | 6. | 7. | 7. | 23. | 0. | 180. |
| 31 | 6. | 8. | 3. | 5. | 5. | 4. | 3. | 5. | 6. | 8. | 8. | 7. | 4. | 7. | 2. | 6. | 3. | 5. | 7. | 35. | 7. | 163. |
| 32 | 4. | 3. | 4. | 8. | 6. | 4. | 5. | 6. | 10. | 3. | 6. | 7. | 2. | 3. | 7. | 7. | 7. | 7. | 6. | 32. | 0. | 121. |
| 33 | 3. | 6. | 8. | 4. | 4. | 9. | 4. | 4. | 7. | 6. | 7. | 5. | 8. | 8. | 6. | 5. | 6. | 5. | 7. | 23. | 0. | 172. |
| 34 | 7. | 6. | 7. | 6. | 5. | 6. | 8. | 3. | 6. | 3. | 3. | 5. | 5. | 7. | 7. | 5. | 1. | 3. | 9. | 39. | 13. | 230. |
| 35 | 7. | 8. | 5. | 6. | 5. | 4. | 6. | 6. | 6. | 5. | 4. | 6. | 2. | 7. | 3. | 5. | 4. | 4. | 10. | 20. | 0. | 179. |
| 36 | 9. | 9. | 9. | 5. | 6. | 6. | 6. | 7. | 5. | 6. | 9. | 3. | 7. | 7. | 5. | 4. | 4. | 6. | 9. | 27. | 0. | 223. |
| 37 | 6. | 7. | 1. | 4. | 4. | 5. | 4. | 7. | 2. | 8. | 5. | 5. | 7. | 7. | 9. | 6. | 5. | 6. | 6. | 28. | 0. | 199. |
| 38 | 8. | 8. | 7. | 5. | 6. | 5. | 6. | 8. | 6. | 5. | 5. | 4. | 7. | 5. | 9. | 7. | 6. | 7. | 5. | 49. | 3. | 210. |
| 39 | 7. | 6. | 5. | 5. | 4. | 4. | 4. | 6. | 7. | 7. | 4. | 8. | 6. | 8. | 7. | 5. | 5. | 5. | 7. | 23. | 3. | 205. |
| 40 | 5. | 7. | 6. | 7. | 8. | 4. | 7. | 7. | 6. | 7. | 6. | 4. | 6. | 8. | 5. | 5. | 7. | 6. | 9. | 23. | 0. | 189. |
| 41 | 6. | 8. | 2. | 7. | 8. | 6. | 4. | 6. | 9. | 7. | 1. | 9. | 3. | 4. | 5. | 9. | 5. | 8. | 9. | 32. | 0. | 95. |
| 42 | 5. | 5. | 5. | 3. | 3. | 6. | 2. | 6. | 6. | 7. | 6. | 9. | 5. | 9. | 3. | 9. | 8. | 9. | 4. | 35. | 8. | 181. |
| 43 | 6. | 5. | 5. | 7. | 5. | 3. | 4. | 4. | 6. | 7. | 6. | 6. | 5. | 3. | 5. | 6. | 4. | 6. | 3. | 33. | 9. | 188. |
| 44 | 6. | 8. | 4. | 3. | 3. | 7. | 6. | 6. | 6. | 5. | 4. | 6. | 5. | 7. | 5. | 8. | 5. | 8. | 6. | 46. | 4. | 139. |
| 45 | 7. | 8. | 3. | 8. | 7. | 4. | 4. | 4. | 4. | 2. | 6. | 6. | 5. | 4. | 9. | 7. | 5. | 7. | 5. | 27. | 6. | 218. |
| 46 | 6. | 5. | 3. | 4. | 3. | 5. | 4. | 6. | 6. | 6. | 3. | 6. | 5. | 5. | 6. | 7. | 6. | 7. | 7. | 22. | 0. | 162. |
| 47 | 5. | 7. | 7. | 5. | 7. | 6. | 6. | 4. | 8. | 4. | 4. | 3. | 8. | 7. | 7. | 8. | 5. | 3. | 9. | 32. | 6. | 241. |
| 48 | 3. | 7. | 5. | 6. | 6. | 4. | 2. | 6. | 7. | 4. | 6. | 9. | 6. | 8. | 5. | 9. | 6. | 6. | 6. | 32. | 8. | 219. |
| 49 | 3. | 10. | 3. | 8. | 5. | 4. | 5. | 6. | 7. | 9. | 5. | 5. | 5. | 6. | 5. | 10. | 3. | 4. | 7. | 23. | 0. | 169. |
| 50 | 6. | 5. | 5. | 4. | 8. | 4. | 3. | 7. | 7. | 4. | 7. | 4. | 4. | 6. | 8. | 6. | 5. | 7. | 8. | 26. | 0. | 173. |
| 51 | 7. | 7. | 10. | 6. | 3. | 10. | 6. | 5. | 4. | 8. | 7. | 3. | 7. | 5. | 9. | 2. | 2. | 1. | 7. | 31. | 0. | 259. |
| 52 | 4. | 8. | 5. | 8. | 10. | 6. | 3. | 9. | 6. | 3. | 6. | 7. | 5. | 7. | 5. | 6. | 7. | 5. | 6. | 23. | 0. | 178. |

ANALYSIS OF VARIANCE - NEW STARTERS VS. RETRAINED OPERATORS
ORIGINAL DATA MATRIX

| OBS.NO. | PF/A | PF/B | PF/C | PF/E | PF/F | PF/G | PF/H | PF/I | PF/L | PF/M | PF/N | PF/O | P/Q1 | PFQ2 | P/Q3 | P/Q4 | STATE | TRAIT | INT. | AGE | EXP. | SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROUP ONE: NEW STARTERS | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 6. | 5. | 5. | 4. | 8. | 4. | 3. | 7. | 7. | 4. | 7. | 4. | 4. | 6. | 8. | 6. | 5. | 7. | 8. | | | 173. |
| 2 | 4. | 6. | 8. | 6. | 9. | 7. | 8. | 5. | 5. | 3. | 4. | 6. | 6. | 4. | 5. | 6. | 2. | 3. | 9. | | | 161. |
| 3 | 6. | 4. | 3. | 2. | 2. | 4. | 3. | 7. | 8. | 3. | 7. | 6. | 5. | 7. | 4. | 7. | 7. | 8. | 7. | | | 115. |
| 4 | 6. | 7. | 4. | 4. | 5. | 3. | 5. | 6. | 6. | 6. | 4. | 8. | 5. | 6. | 3. | 6. | 6. | 7. | 3. | | | 159. |
| 5 | 3. | 10. | 3. | 8. | 5. | 4. | 5. | 6. | 7. | 9. | 5. | 5. | 5. | 6. | 5. | 10. | 3. | 4. | 7. | | | 169. |
| 6 | 7. | 8. | 5. | 6. | 5. | 4. | 6. | 6. | 6. | 5. | 4. | 6. | 2. | 7. | 3. | 5. | 4. | 4. | 10. | | | 179. |
| 7 | 5. | 8. | 2. | 4. | 3. | 7. | 3. | 5. | 6. | 7. | 7. | 8. | 4. | 8. | 7. | 6. | 4. | 6. | 5. | | | 193. |
| 8 | 6. | 8. | 5. | 7. | 5. | 8. | 7. | 4. | 5. | 4. | 6. | 6. | 6. | 4. | 9. | 5. | 6. | 7. | 8. | | | 196. |
| 9 | 3. | 7. | 5. | 6. | 6. | 4. | 2. | 6. | 7. | 4. | 6. | 9. | 6. | 8. | 5. | 9. | 6. | 6. | 6. | | | 219. |
| 10 | 9. | 9. | 9. | 5. | 6. | 6. | 6. | 7. | 5. | 6. | 9. | 3. | 7. | 7. | 5. | 4. | 4. | 6. | 9. | | | 223. |
| 11 | 7. | 6. | 7. | 6. | 5. | 6. | 8. | 3. | 6. | 3. | 3. | 5. | 5. | 7. | 7. | 5. | 1. | 3. | 9. | | | 230. |
| 12 | 3. | 5. | 4. | 1. | 4. | 4. | 4. | 5. | 2. | 2. | 10. | 5. | 5. | 5. | 9. | 3. | 5. | 5. | 7. | | | 235. |
| 13 | 4. | 3. | 4. | 8. | 6. | 4. | 5. | 6. | 10. | 3. | 6. | 7. | 2. | 3. | 7. | 7. | 7. | 7. | 6. | | | 121. |
| 14 | 6. | 5. | 3. | 4. | 3. | 5. | 4. | 6. | 6. | 6. | 3. | 6. | 5. | 5. | 6. | 7. | 6. | 7. | 7. | | | 162. |
| 15 | 3. | 6. | 8. | 4. | 4. | 9. | 4. | 4. | 7. | 6. | 7. | 5. | 8. | 8. | 6. | 5. | 6. | 5. | 7. | | | 172. |
| 16 | 6. | 7. | 1. | 4. | 4. | 5. | 4. | 7. | 2. | 8. | 5. | 5. | 7. | 7. | 9. | 6. | 5. | 6. | 6. | | | 199. |
| 17 | 5. | 7. | 7. | 5. | 7. | 6. | 6. | 4. | 8. | 4. | 4. | 3. | 8. | 7. | 7. | 8. | 5. | 3. | 9. | | | 241. |
| GROUP TWO: RETRAINED OPERATORS | | | | | | | | | | | | | | | | | | | | | | |
| 18 | 5. | 9. | 6. | 7. | 7. | 6. | 7. | 8. | 8. | 2. | 6. | 5. | 5. | 4. | 3. | 3. | 5. | 5. | 7. | | | 101. |
| 19 | 5. | 4. | 7. | 6. | 6. | 4. | 7. | 8. | 9. | 5. | 4. | 7. | 3. | 5. | 2. | 8. | 6. | 7. | 5. | | | 138. |
| 20 | 6. | 8. | 4. | 3. | 3. | 7. | 6. | 6. | 6. | 5. | 4. | 6. | 5. | 7. | 5. | 8. | 5. | 8. | 6. | | | 139. |
| 21 | 6. | 3. | 8. | 5. | 5. | 4. | 6. | 7. | 8. | 6. | 3. | 6. | 4. | 6. | 4. | 8. | 6. | 6. | 6. | | | 142. |
| 22 | 5. | 3. | 4. | 5. | 6. | 5. | 4. | 7. | 7. | 5. | 5. | 6. | 5. | 5. | 4. | 7. | 6. | 5. | 7. | | | 155. |
| 23 | 8. | 9. | 2. | 5. | 5. | 3. | 4. | 7. | 9. | 6. | 4. | 6. | 2. | 7. | 1. | 9. | 8. | 4. | 6. | | | 169. |
| 24 | 5. | 5. | 4. | 6. | 10. | 7. | 7. | 6. | 6. | 6. | 5. | 5. | 3. | 5. | 6. | 6. | 8. | 6. | 4. | | | 174. |
| 25 | 7. | 8. | 4. | 7. | 8. | 3. | 5. | 7. | 8. | 7. | 4. | 6. | 6. | 5. | 5. | 5. | 7. | 5. | 6. | | | 190. |
| 26 | 5. | 8. | 5. | 6. | 5. | 4. | 3. | 5. | 10. | 6. | 7. | 6. | 4. | 8. | 3. | 9. | 5. | 2. | 6. | | | 193. |
| 27 | 6. | 8. | 7. | 8. | 3. | 6. | 7. | 4. | 6. | 3. | 8. | 3. | 9. | 5. | 7. | 4. | 5. | 2. | 7. | | | 195. |
| 28 | 7. | 6. | 7. | 5. | 7. | 2. | 7. | 3. | 9. | 6. | 1. | 5. | 5. | 5. | 7. | 5. | 3. | 1. | 6. | | | 205. |
| 29 | 8. | 8. | 7. | 5. | 6. | 5. | 6. | 8. | 6. | 5. | 5. | 4. | 7. | 5. | 9. | 7. | 6. | 7. | 5. | | | 210. |
| 30 | 7. | 8. | 3. | 8. | 7. | 4. | 4. | 4. | 4. | 2. | 6. | 6. | 5. | 4. | 9. | 7. | 5. | 7. | 5. | | | 218. |
| 31 | 7. | 7. | 10. | 6. | 3. | 10. | 6. | 5. | 4. | 8. | 7. | 3. | 7. | 5. | 9. | 2. | 2. | 1. | 7. | | | 259. |
| 32 | 6. | 8. | 2. | 7. | 8. | 6. | 4. | 6. | 9. | 7. | 1. | 9. | 3. | 4. | 5. | 9. | 5. | 8. | 9. | | | 95. |
| 33 | 5. | 5. | 5. | 6. | 5. | 6. | 3. | 4. | 9. | 8. | 4. | 8. | 7. | 8. | 4. | 7. | 7. | 7. | 9. | | | 140. |
| 34 | 6. | 8. | 3. | 5. | 5. | 4. | 3. | 5. | 6. | 8. | 8. | 7. | 4. | 7. | 2. | 6. | 3. | 5. | 7. | | | 163. |
| 35 | 5. | 9. | 3. | 9. | 6. | 6. | 3. | 6. | 6. | 4. | 6. | 6. | 3. | 8. | 5. | 5. | 3. | 5. | 6. | | | 165. |
| 36 | 5. | 8. | 4. | 4. | 3. | 4. | 2. | 5. | 6. | 5. | 3. | 8. | 7. | 8. | 3. | 5. | 7. | 5. | 6. | | | 170. |
| 37 | 4. | 8. | 5. | 8. | 10. | 6. | 3. | 9. | 6. | 3. | 6. | 7. | 5. | 7. | 5. | 6. | 7. | 5. | 6. | | | 178. |
| 38 | 7. | 9. | 4. | 6. | 3. | 3. | 1. | 6. | 8. | 5. | 2. | 9. | 6. | 7. | 3. | 10. | 6. | 7. | 7. | | | 180. |
| 39 | 5. | 5. | 5. | 3. | 3. | 6. | 2. | 6. | 6. | 7. | 6. | 9. | 5. | 9. | 3. | 9. | 8. | 9. | 4. | | | 181. |
| 40 | 7. | 7. | 5. | 2. | 4. | 7. | 7. | 5. | 6. | 5. | 8. | 4. | 3. | 5. | 5. | 5. | 4. | 3. | 5. | | | 182. |
| 41 | 5. | 9. | 2. | 4. | 3. | 2. | 3. | 4. | 3. | 5. | 6. | 8. | 5. | 9. | 2. | 7. | 7. | 8. | 8. | | | 187. |
| 42 | 6. | 10. | 4. | 6. | 2. | 6. | 6. | 6. | 6. | 8. | 3. | 6. | 5. | 7. | 7. | 6. | 4. | 5. | 6. | | | 188. |
| 43 | 6. | 5. | 5. | 7. | 5. | 3. | 4. | 4. | 6. | 7. | 6. | 6. | 5. | 3. | 5. | 6. | 4. | 6. | 3. | | | 188. |
| 44 | 5. | 7. | 6. | 7. | 8. | 4. | 7. | 7. | 6. | 7. | 6. | 4. | 6. | 8. | 5. | 5. | 7. | 6. | 9. | | | 189. |
| 45 | 7. | 6. | 5. | 5. | 4. | 4. | 4. | 6. | 7. | 7. | 4. | 8. | 6. | 8. | 7. | 5. | 5. | 5. | 7. | | | 205. |
| 46 | 7. | 7. | 3. | 4. | 7. | 8. | 5. | 4. | 3. | 6. | 7. | 4. | 8. | 6. | 8. | 4. | 2. | 3. | 9. | | | 207. |
| 47 | 6. | 6. | 2. | 5. | 6. | 7. | 4. | 5. | 4. | 5. | 7. | 5. | 7. | 7. | 7. | 3. | 6. | 5. | 8. | | | 222. |
| 48 | 8. | 8. | 5. | 6. | 8. | 7. | 5. | 3. | 6. | 4. | 4. | 4. | 8. | 4. | 6. | 3. | 5. | 3. | 6. | | | 223. |
| 49 | 6. | 8. | 4. | 3. | 6. | 6. | 2. | 4. | 4. | 5. | 8. | 3. | 7. | 5. | 8. | 2. | 3. | 4. | 7. | | | 226. |
| 50 | 6. | 8. | 4. | 9. | 7. | 3. | 10. | 6. | 6. | 6. | 3. | 7. | 7. | 10. | 3. | 9. | 5. | 4. | 5. | | | 231. |
| 51 | 7. | 8. | 6. | 4. | 6. | 7. | 6. | 4. | 9. | 4. | 8. | 8. | 5. | 8. | 9. | 6. | 3. | 2. | 7. | | | 231. |
| 52 | 7. | 7. | 8. | 6. | 6. | 7. | 5. | 1. | 3. | 4. | 9. | 1. | 8. | 9. | 5. | 2. | 2. | 1. | 9. | | | 251. |

| SOURCE | SS | DF | MS | F |
|---|---|---|---|---|
| BETWEEN SUBJ | 3599.162 | | | |
| FACTOR A | 1.108 | 1 | 1.108 | 0.02 |
| SUBJ W GRP | 3598.054 | 50 | 71.961 | |
| WITHIN SUBJ | ********** | | | |
| FACTOR B | ********** | 19 | 84015.256 | ***** |
| FACTOR AB | 55.412 | 19 | 2.916 | 0.04 |
| B X SS W GRP | 69396.619 | 950 | 73.049 | |

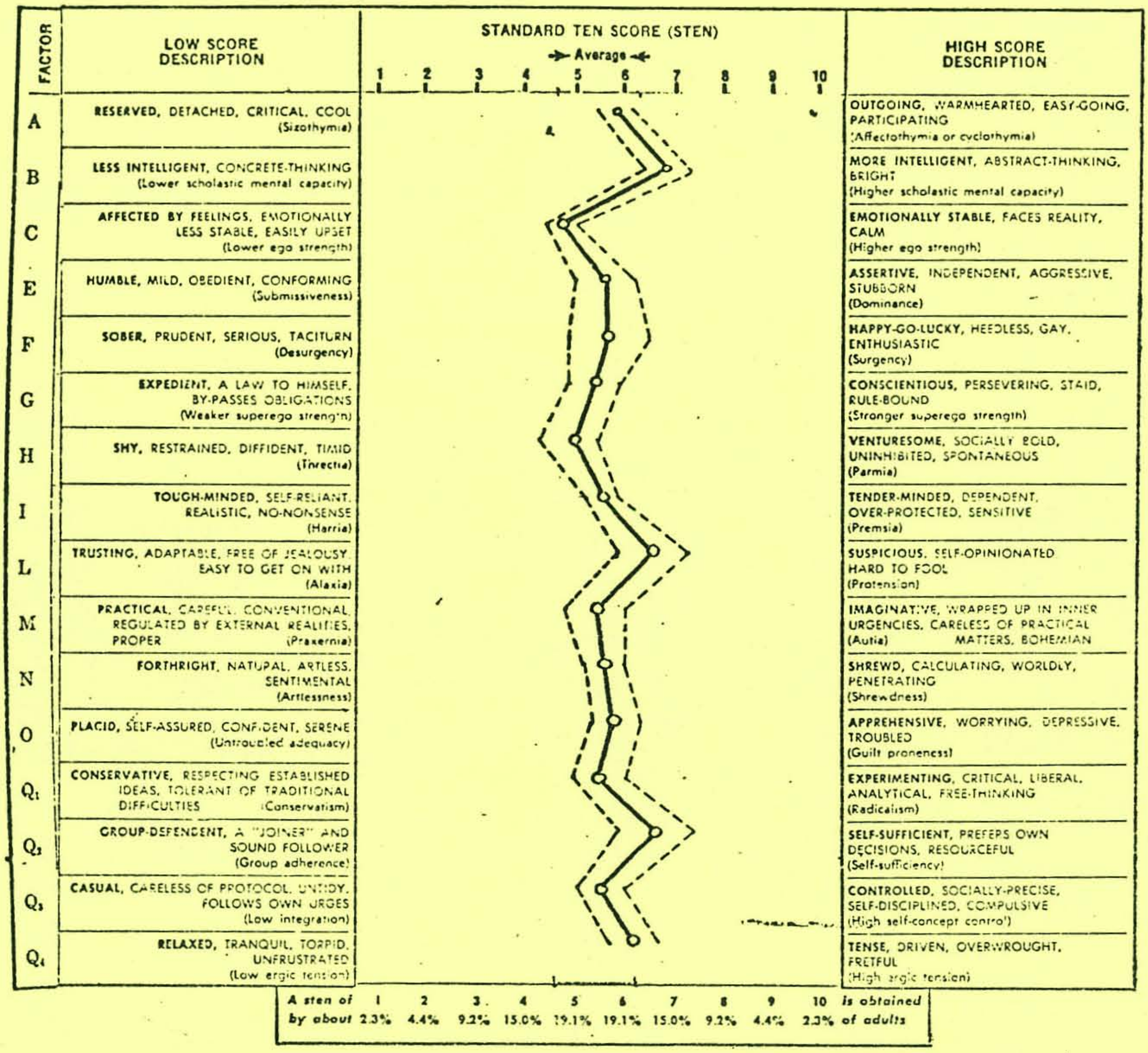
SIMPLE EFFECTS ANALYSIS

| FACTOR A AT LEVEL: | SS | DF | MS | F |
|---|---|---|---|---|
| B 1 | 8.28 | 1 | 8.28 | 0.11 |
| B 2 | 4.31 | 1 | 4.31 | 0.06 |
| B 3 | 0.08 | 1 | 0.08 | 0.00 |
| B 4 | 5.87 | 1 | 5.87 | 0.08 |
| B 5 | 2.66 | 1 | 2.66 | 0.04 |
| B 6 | 0.10 | 1 | 0.10 | 0.00 |
| B 7 | 0.08 | 1 | 0.08 | 0.00 |
| B 8 | 0.06 | 1 | 0.06 | 0.00 |
| B 9 | 1.56 | 1 | 1.56 | 0.02 |
| B10 | 4.17 | 1 | 4.17 | 0.06 |
| B11 | 2.30 | 1 | 2.30 | 0.03 |
| B12 | 0.26 | 1 | 0.26 | 0.00 |
| B13 | 0.21 | 1 | 0.21 | 0.00 |
| B14 | 0.43 | 1 | 0.43 | 0.01 |
| B15 | 11.56 | 1 | 11.56 | 0.16 |
| B16 | 0.62 | 1 | 0.62 | 0.01 |
| B17 | 1.17 | 1 | 1.17 | 0.02 |
| B18 | 4.33 | 1 | 4.33 | 0.06 |
| B19 | 6.93 | 1 | 6.93 | 0.09 |
| B20 | 1.55 | 1 | 1.55 | 0.02 |
| ERROR | 72994.67 | 1000 | 72.99 | |

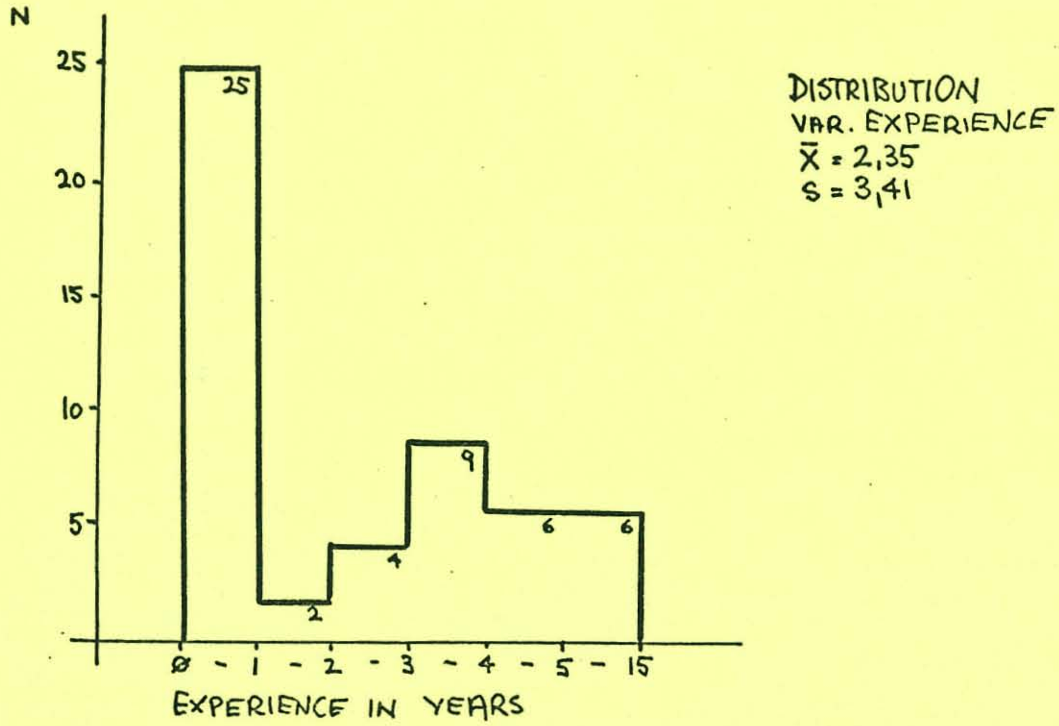
| FACTOR B AT LEVEL: | SS | DF | MS | F |
|---|---|---|---|---|
| A 1 | 520662.05 | 19 | 27403.27 | ***** |
| A 2 | 1075683.23 | 19 | 56614.91 | ***** |
| ERROR | 69396.62 | 950 | 73.05 | |

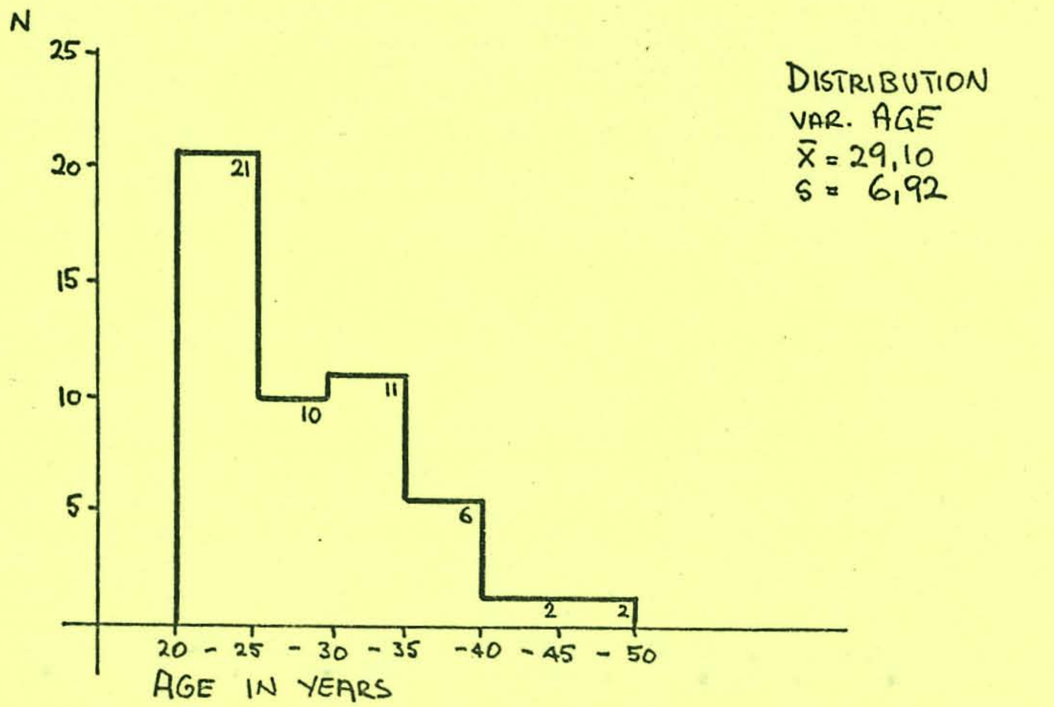


APP. B.2./2

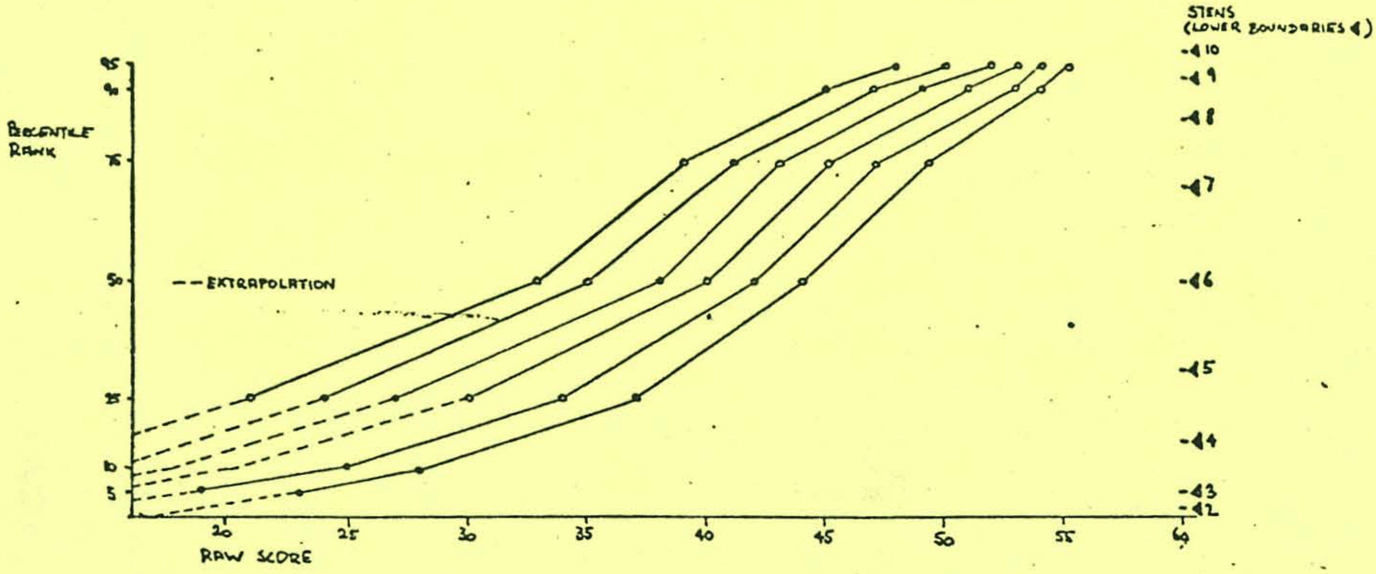



B.3. Mean profile of 16PF-scores

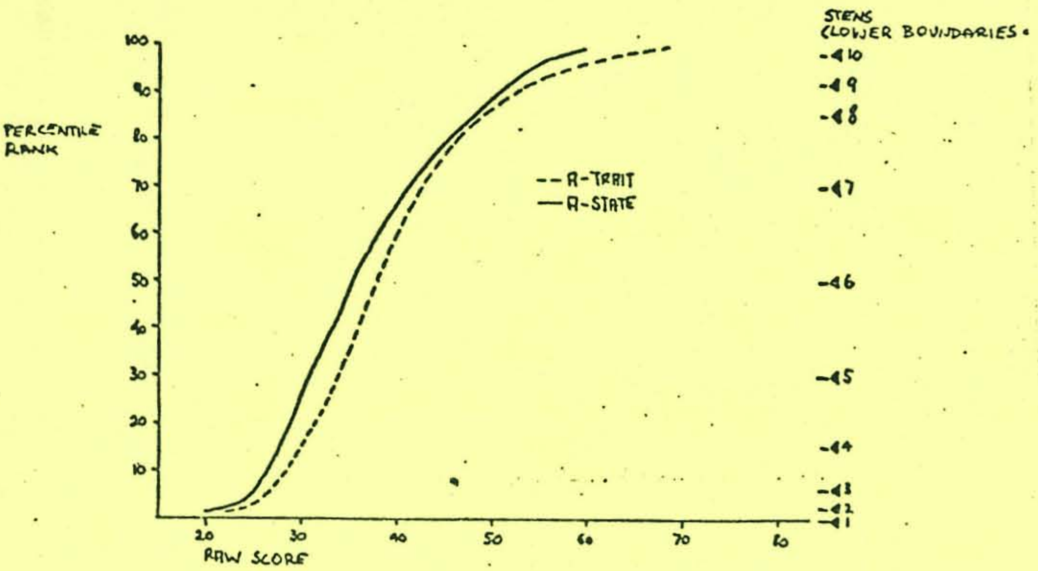



B.4. Distribution of the variables EXPERIENCE and AGE



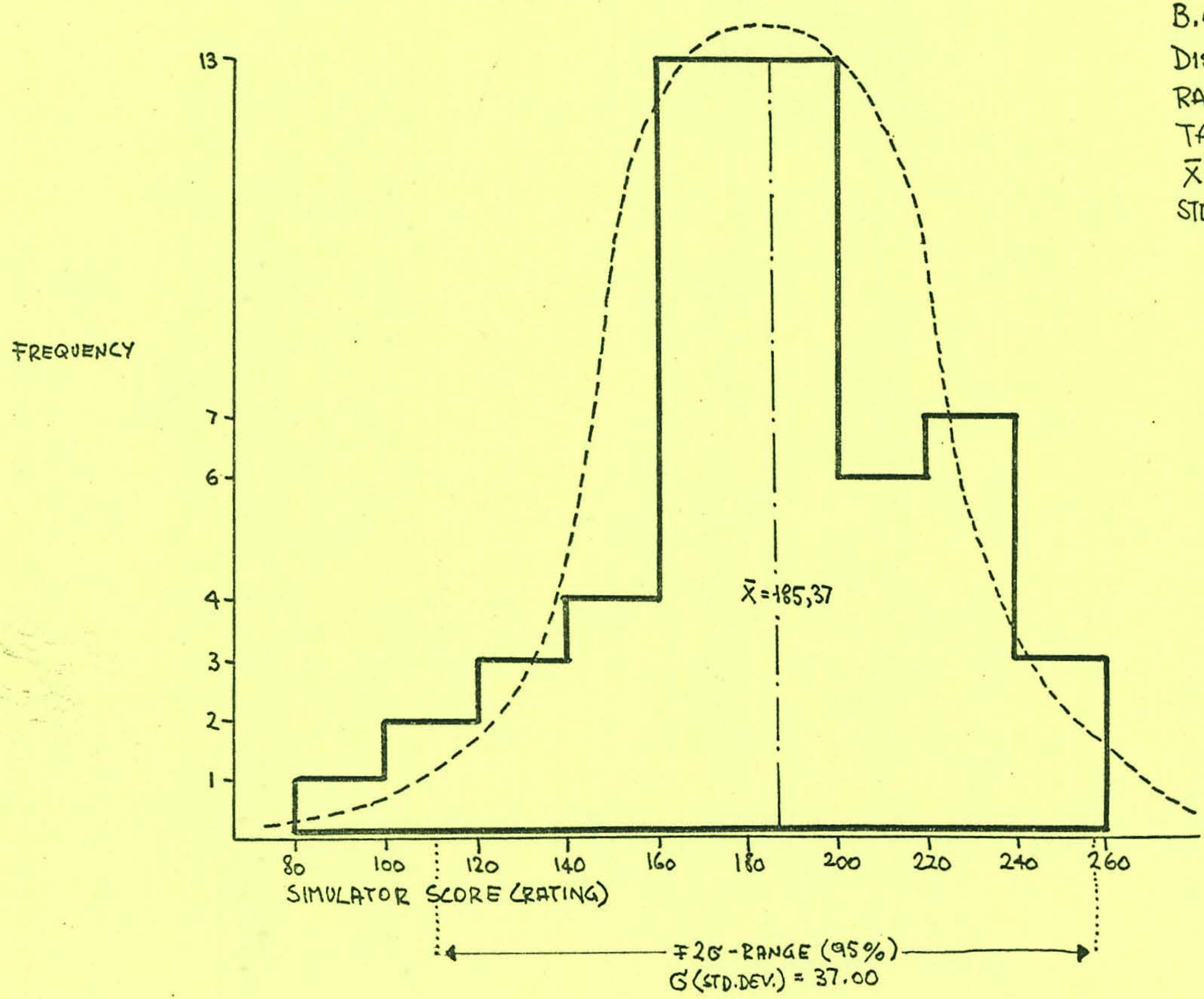

STEN-TRANSFORMATION OF RAW-SCORES OF RAVEN'S PMT



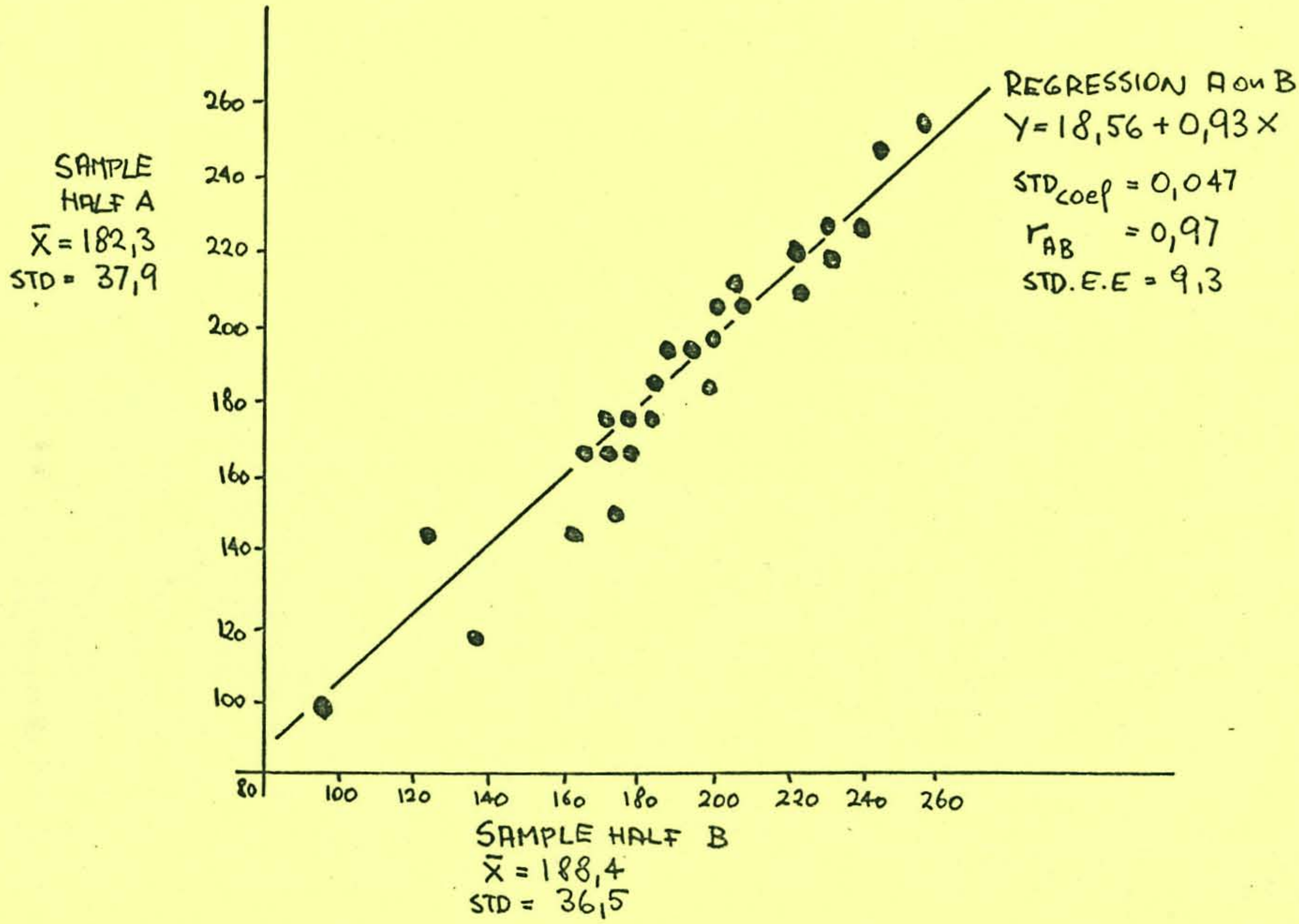

STEN-TRANSFORMATION OF RAW-SCORES OF THE STAI

B.5. STEN - Transformation of STAI- and RAVEN (PM) - scores

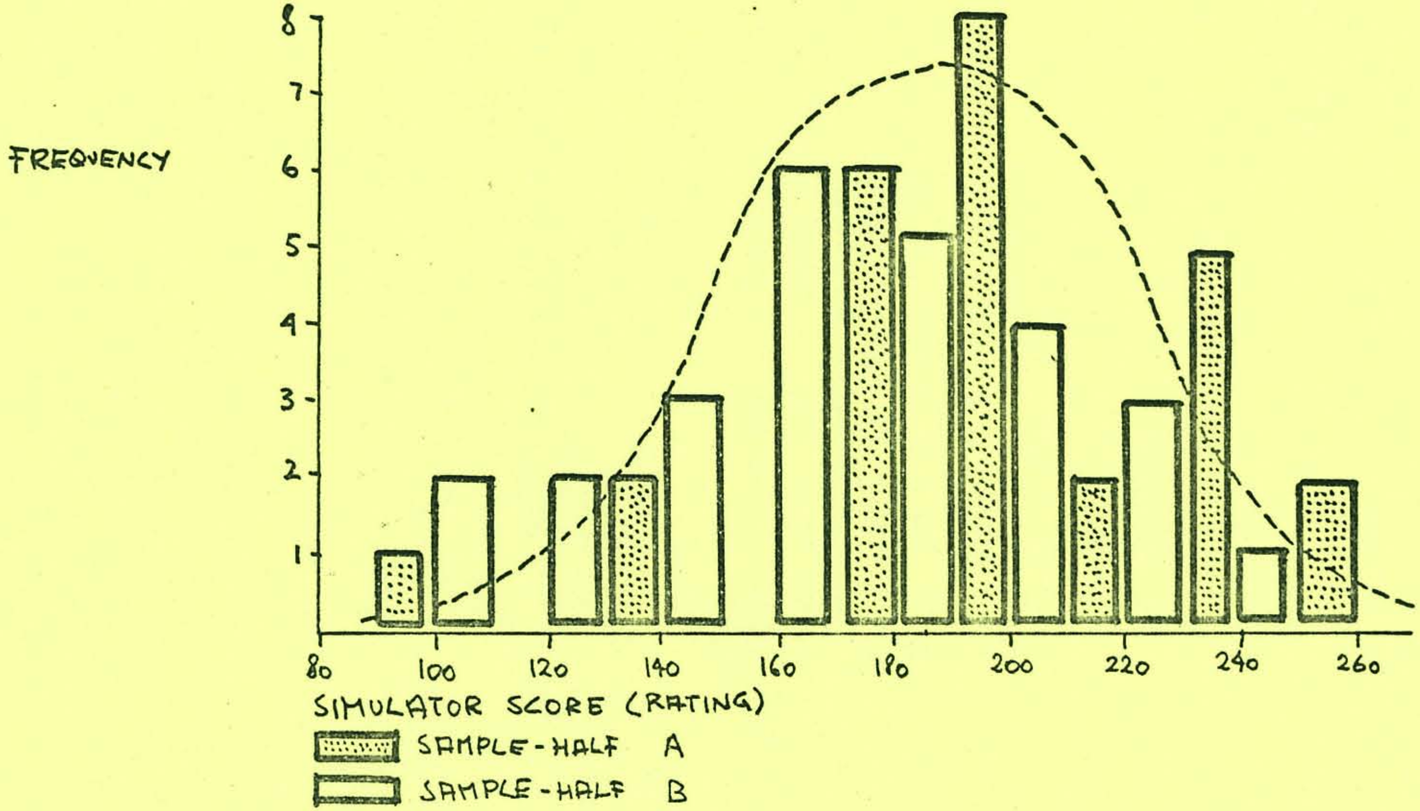
B.6.
DISTRIBUTION OF RATING-SCORES FOR TASK PERFORMANCE
$\bar{X} = 185,37$
STD = 37,00




$$\chi^2 = 9{,}26 < \chi^2_{95\,(6\,df)} = 12{,}6$$




B.7. Scattergram and split-half-regression of the simulator-score




B.8. Distribution of the sample-split

APPENDIX C

STEP NUMBER 21 ENTER VARIABLE 12
STANDARD ERROR OF ESTIMATE= 14.478
MULTIPLE CORRELATION COEFFICIENT = 0.954
GOODNESS OF FIT: 99.9922%
CONSTANT TERM= 127.0743

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | .4682E 01 | .1868E 01 | .6283E 01 | .1700E 00 |
| 2 | .5069E 01 | .1753E 01 | .8360E 01 | .2418E 00 |
| 3 | .6913E 01 | .1554E 01 | .1978E 02 | .3732E 00 |
| 4 | -.1100E 01 | .1551E 01 | .5034E 00 | -.5279E-01 |
| 5 | .1203E 01 | .1369E 01 | .7728E 00 | .6356E-01 |
| 6 | -.3429E 01 | .1487E 01 | .5313E 01 | -.1648E 00 |
| 7 | -.3876E 01 | .1582E 01 | .6001E 01 | -.1976E 00 |
| 8 | -.2978E 01 | .1828E 01 | .2654E 01 | -.1240E 00 |
| 9 | -.6884E 01 | .1729E 01 | .2640E 02 | -.4624E 00 |
| 10 | .2058E 01 | .1385E 01 | .2208E 01 | .2686E-01 |
| 11 | .9671E 00 | .1481E 01 | .4263E 00 | .5336E-01 |
| 12 | -.1956E 00 | .2033E 01 | .9256E-02 | -.9655E-02 |
| 13 | -.2236E 01 | .1851E 01 | .1459E 01 | -.1031E 00 |
| 14 | .2891E 01 | .1810E 01 | .2553E 01 | .1318E 00 |
| 15 | .9259E 01 | .1275E 01 | .5274E 02 | .5485E 00 |
| 16 | .2380E 01 | .1723E 01 | .1921E 01 | .1331E 00 |
| 17 | .8494E 01 | .2133E 01 | .1586E 02 | .3962E 00 |
| 18 | -.9902E 01 | .1861E 01 | .2833E 02 | -.5344E 00 |
| 19 | .3683E 00 | .1680E 01 | .4802E-01 | .1605E-01 |
| 20 | -.7079E 00 | .4263E 00 | .2757E 01 | -.1325E 00 |
| 21 | .4470E 01 | .1090E 01 | .1681E 02 | .4115E 00 |

STEP NUMBER 19 ENTER VARIABLE 13
STANDARD ERROR OF ESTIMATE= 17.540
MULTIPLE CORRELATION COEFFICIENT = 0.927
GOODNESS OF FIT: 85.8968%
CONSTANT TERM= 108.8429

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | .6396E 01 | .2194E 01 | .8498E 01 | .2323E 00 |
| 2 | .1707E 01 | .1809E 01 | .8902E 00 | .8140E-01 |
| 3 | .5972E 01 | .1845E 01 | .1048E 02 | .3224E 00 |
| 4 | .3522E 00 | .1798E 01 | .3838E-01 | .1690E-01 |
| 5 | .2429E 01 | .1561E 01 | .2422E 01 | .1283E 00 |
| 6 | -.4482E 01 | .1773E 01 | .6391E 01 | -.2154E 00 |
| 7 | -.1756E 01 | .1785E 01 | .9679E 00 | -.8951E-01 |
| 8 | -.4703E 01 | .2142E 01 | .4821E 01 | -.1958E 00 |
| 9 | -.9720E 01 | .2074E 01 | .2197E 02 | -.5059E 00 |
| 10 | .8475E 00 | .1628E 01 | .2710E 00 | .3989E-01 |
| 11 | .2305E 01 | .1748E 01 | .1738E 01 | .1272E 00 |
| 12 | .2208E 01 | .2335E 01 | .8943E 00 | .1090E 00 |
| 13 | .2336E 00 | .2122E 01 | .1212E-01 | .1077E-01 |
| 14 | .5997E 01 | .1991E 01 | .9077E 01 | .2734E 00 |
| 15 | .8239E 01 | .1508E 01 | .2984E 02 | .4881E 00 |
| 16 | .4313E 01 | .1974E 01 | .4774E 01 | .2404E 00 |
| 17 | .4900E 01 | .2345E 01 | .4366E 01 | .2286E 00 |
| 18 | -.9252E 01 | .2198E 01 | .1772E 02 | -.4993E 00 |
| 19 | -.2220E 01 | .1815E 01 | .1497E 01 | -.9679E-01 |



APP. C.2.
RESULTS OF MLRA II

PERSONALITY CORRELATES TO PERFORMANCE UNDER STRESS          M.P.LEHMANN

ORIGINAL DATA MATRIX

| OBS.NO. | PF/A | PF/B | PF/C | PF/E | PF/F | PF/G | PF/H | PF/I | PF/L | PF/M | PF/N | PF/O | P/Q1 | PFQ2 | P/Q3 | P/Q4 | STATE | TRAIT | INT. | AGE | EXP. | SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6. | 5. | 5. | 4. | 8. | 4. | 3. | 7. | 7. | 4. | 7. | 4. | 4. | 6. | 8. | 6. | 5. | 7. | 8. | | | 173. |
| 2 | 4. | 6. | 8. | 6. | 9. | 7. | 8. | 5. | 5. | 3. | 4. | 6. | 6. | 4. | 5. | 6. | 2. | 3. | 9. | | | 161. |
| 3 | 6. | 4. | 3. | 2. | 2. | 4. | 3. | 7. | 8. | 3. | 7. | 6. | 5. | 7. | 4. | 7. | 7. | 8. | 7. | | | 115. |
| 4 | 6. | 7. | 4. | 4. | 5. | 3. | 5. | 6. | 6. | 6. | 4. | 8. | 5. | 6. | 3. | 6. | 6. | 7. | 3. | | | 159. |
| 5 | 3. | 10. | 3. | 8. | 5. | 4. | 5. | 6. | 7. | 9. | 5. | 5. | 5. | 6. | 5. | 10. | 3. | 4. | 7. | | | 169. |
| 6 | 7. | 8. | 5. | 6. | 5. | 4. | 6. | 6. | 6. | 5. | 4. | 6. | 2. | 7. | 3. | 5. | 4. | 4. | 10. | | | 179. |
| 7 | 5. | 8. | 2. | 4. | 3. | 7. | 3. | 5. | 6. | 7. | 7. | 8. | 4. | 8. | 7. | 6. | 4. | 6. | 5. | | | 193. |
| 8 | 6. | 8. | 5. | 7. | 5. | 8. | 7. | 4. | 5. | 4. | 6. | 6. | 6. | 4. | 9. | 5. | 6. | 7. | 8. | | | 196. |
| 9 | 3. | 7. | 5. | 6. | 6. | 4. | 2. | 6. | 7. | 4. | 6. | 9. | 6. | 8. | 5. | 9. | 6. | 6. | 6. | | | 219. |
| 10 | 9. | 9. | 9. | 5. | 6. | 6. | 6. | 7. | 5. | 6. | 9. | 3. | 7. | 7. | 5. | 4. | 4. | 6. | 9. | | | 223. |
| 11 | 7. | 6. | 7. | 6. | 5. | 6. | 8. | 3. | 6. | 3. | 3. | 5. | 5. | 7. | 7. | 5. | 1. | 3. | 9. | | | 230. |
| 12 | 3. | 5. | 4. | 1. | 4. | 4. | 4. | 5. | 2. | 2. | 10. | 5. | 5. | 5. | 9. | 3. | 5. | 5. | 7. | | | 235. |
| 13 | 4. | 3. | 4. | 8. | 6. | 4. | 5. | 6. | 10. | 3. | 6. | 7. | 2. | 3. | 7. | 7. | 7. | 7. | 6. | | | 121. |
| 14 | 6. | 5. | 3. | 4. | 3. | 5. | 4. | 6. | 6. | 6. | 3. | 6. | 5. | 5. | 6. | 7. | 6. | 7. | 7. | | | 162. |
| 15 | 3. | 6. | 8. | 4. | 4. | 9. | 4. | 4. | 7. | 6. | 7. | 5. | 8. | 8. | 6. | 5. | 6. | 5. | 7. | | | 172. |
| 16 | 6. | 7. | 1. | 4. | 4. | 5. | 4. | 7. | 2. | 8. | 5. | 5. | 7. | 7. | 9. | 6. | 5. | 6. | 6. | | | 199. |
| 17 | 5. | 7. | 7. | 5. | 7. | 6. | 6. | 4. | 8. | 4. | 4. | 3. | 8. | 7. | 7. | 8. | 5. | 3. | 9. | | | 241. |
| 18 | 5. | 9. | 6. | 7. | 7. | 6. | 7. | 8. | 8. | 2. | 6. | 5. | 5. | 4. | 3. | 3. | 5. | 5. | 7. | | | 101. |
| 19 | 5. | 4. | 7. | 6. | 6. | 4. | 7. | 8. | 9. | 5. | 4. | 7. | 3. | 5. | 2. | 8. | 6. | 7. | 5. | | | 138. |
| 20 | 6. | 8. | 4. | 3. | 3. | 7. | 6. | 6. | 6. | 5. | 4. | 6. | 5. | 7. | 5. | 8. | 5. | 8. | 6. | | | 139. |
| 21 | 6. | 3. | 8. | 5. | 5. | 4. | 6. | 7. | 8. | 6. | 3. | 6. | 4. | 6. | 4. | 8. | 6. | 6. | 6. | | | 142. |
| 22 | 5. | 3. | 4. | 5. | 6. | 5. | 4. | 7. | 7. | 5. | 5. | 6. | 5. | 5. | 4. | 7. | 6. | 5. | 7. | | | 155. |
| 23 | 8. | 9. | 2. | 5. | 5. | 3. | 4. | 7. | 9. | 6. | 4. | 6. | 2. | 7. | 1. | 9. | 8. | 4. | 6. | | | 169. |
| 24 | 5. | 5. | 4. | 6. | 10. | 7. | 7. | 6. | 6. | 6. | 5. | 5. | 3. | 5. | 6. | 6. | 8. | 6. | 4. | | | 174. |
| 25 | 7. | 8. | 4. | 7. | 8. | 3. | 5. | 7. | 8. | 7. | 4. | 6. | 6. | 5. | 5. | 5. | 7. | 5. | 6. | | | 190. |
| 26 | 5. | 8. | 5. | 6. | 5. | 4. | 3. | 5. | 10. | 6. | 7. | 6. | 4. | 8. | 3. | 9. | 5. | 2. | 6. | | | 193. |
| 27 | 6. | 8. | 7. | 8. | 3. | 6. | 7. | 4. | 6. | 3. | 8. | 3. | 9. | 5. | 7. | 4. | 5. | 2. | 7. | | | 195. |
| 28 | 7. | 6. | 7. | 5. | 7. | 2. | 7. | 3. | 9. | 6. | 1. | 5. | 5. | 5. | 7. | 5. | 3. | 1. | 6. | | | 205. |
| 29 | 8. | 8. | 7. | 5. | 6. | 5. | 6. | 8. | 6. | 5. | 5. | 4. | 7. | 5. | 9. | 7. | 6. | 7. | 5. | | | 210. |
| 30 | 7. | 8. | 3. | 8. | 7. | 4. | 4. | 4. | 4. | 2. | 6. | 6. | 5. | 4. | 9. | 7. | 5. | 7. | 5. | | | 218. |
| 31 | 7. | 7. | 10. | 6. | 3. | 10. | 6. | 5. | 4. | 8. | 7. | 3. | 7. | 5. | 9. | 2. | 2. | 1. | 7. | | | 259. |
| 32 | 6. | 8. | 2. | 7. | 8. | 6. | 4. | 6. | 9. | 7. | 1. | 9. | 3. | 4. | 5. | 9. | 5. | 8. | 9. | | | 95. |
| 33 | 5. | 5. | 5. | 6. | 5. | 6. | 3. | 4. | 9. | 8. | 4. | 8. | 7. | 8. | 4. | 7. | 7. | 7. | 9. | | | 140. |
| 34 | 6. | 8. | 3. | 5. | 5. | 4. | 3. | 5. | 6. | 8. | 8. | 7. | 4. | 7. | 2. | 6. | 3. | 5. | 7. | | | 163. |
| 35 | 5. | 9. | 3. | 9. | 6. | 6. | 3. | 6. | 6. | 4. | 6. | 6. | 3. | 8. | 5. | 5. | 3. | 5. | 6. | | | 165. |
| 36 | 5. | 8. | 4. | 4. | 3. | 4. | 2. | 5. | 6. | 5. | 3. | 8. | 7. | 8. | 3. | 5. | 7. | 5. | 6. | | | 170. |
| 37 | 4. | 8. | 5. | 8. | 10. | 6. | 3. | 9. | 6. | 3. | 6. | 7. | 5. | 7. | 5. | 6. | 7. | 5. | 6. | | | 178. |
| 38 | 7. | 9. | 4. | 6. | 3. | 3. | 1. | 6. | 8. | 5. | 2. | 9. | 6. | 7. | 3. | 10. | 6. | 7. | 7. | | | 180. |
| 39 | 5. | 5. | 5. | 3. | 3. | 6. | 2. | 6. | 6. | 7. | 6. | 9. | 5. | 9. | 3. | 9. | 8. | 9. | 4. | | | 181. |
| 40 | 7. | 7. | 5. | 2. | 4. | 7. | 7. | 5. | 6. | 5. | 8. | 4. | 3. | 5. | 5. | 5. | 4. | 3. | 5. | | | 182. |
| 41 | 5. | 9. | 2. | 4. | 3. | 2. | 3. | 4. | 3. | 5. | 6. | 8. | 5. | 9. | 2. | 7. | 7. | 8. | 8. | | | 187. |
| 42 | 6. | 10. | 4. | 6. | 2. | 6. | 6. | 6. | 6. | 8. | 3. | 6. | 5. | 7. | 7. | 6. | 4. | 5. | 6. | | | 188. |
| 43 | 6. | 5. | 5. | 7. | 5. | 3. | 4. | 4. | 6. | 7. | 6. | 6. | 5. | 3. | 5. | 6. | 4. | 6. | 3. | | | 188. |
| 44 | 5. | 7. | 6. | 7. | 8. | 4. | 7. | 7. | 6. | 7. | 6. | 4. | 6. | 8. | 5. | 5. | 7. | 6. | 9. | | | 189. |
| 45 | 7. | 6. | 5. | 5. | 4. | 4. | 4. | 6. | 7. | 7. | 4. | 8. | 6. | 8. | 7. | 5. | 5. | 5. | 7. | | | 205. |
| 46 | 7. | 7. | 3. | 4. | 7. | 8. | 5. | 4. | 3. | 6. | 7. | 4. | 8. | 6. | 8. | 4. | 2. | 3. | 9. | | | 207. |
| 47 | 6. | 6. | 2. | 5. | 6. | 7. | 4. | 5. | 4. | 5. | 7. | 5. | 7. | 7. | 7. | 3. | 6. | 5. | 8. | | | 222. |
| 48 | 8. | 8. | 5. | 6. | 8. | 7. | 5. | 3. | 6. | 4. | 4. | 4. | 8. | 4. | 6. | 3. | 5. | 3. | 6. | | | 223. |
| 49 | 6. | 8. | 4. | 3. | 6. | 6. | 2. | 4. | 4. | 5. | 8. | 3. | 7. | 5. | 8. | 2. | 3. | 4. | 7. | | | 228. |
| 50 | 6. | 6. | 4. | 9. | 7. | 3. | 10. | 6. | 6. | 6. | 3. | 7. | 7. | 10. | 3. | 9. | 5. | 4. | 5. | | | 231. |
| 51 | 7. | 8. | 6. | 4. | 6. | 7. | 6. | 4. | 9. | 4. | 8. | 8. | 5. | 8. | 9. | 6. | 3. | 2. | 7. | | | 231. |
| 52 | 7. | 7. | 8. | 6. | 6. | 7. | 5. | 1. | 3. | 4. | 9. | 1. | 8. | 9. | 5. | 2. | 2. | 1. | 9. | | | 251. |

PERS.CORR./STRESS - FIN TWOTWELVE.FOUT ONESEVENTEIGHT/

| | | |
|---|---|---|
| 1 | 5.81 | 1.34 |
| 2 | 6.94 | 1.76 |
| 3 | 4.83 | 2.00 |
| 4 | 5.42 | 1.78 |
| 5 | 5.44 | 1.95 |
| 6 | 5.23 | 1.78 |
| 7 | 4.83 | 1.89 |
| 8 | 5.48 | 1.54 |
| 9 | 6.31 | 1.93 |
| 10 | 5.29 | 1.74 |
| 11 | 5.40 | 2.04 |
| 12 | 5.81 | 1.83 |
| 13 | 5.38 | 1.71 |
| 14 | 6.31 | 1.69 |
| 15 | 5.50 | 2.19 |
| 16 | 6.02 | 2.06 |
| 17 | 5.04 | 1.73 |
| 18 | 5.12 | 2.00 |
| 19 | 6.71 | 1.61 |
| 20 | 185.37 | 37.00 |

SIMPLE CORRELATION CO-EFFICIENTS

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1.0000 | 1 | 2 | 0.2350 | 1 | 3 | 0.1189 | 1 | 4 | -0.0557 | 1 | 5 | -0.0267 | 1 | 6 | 0.0107 |
| 1 | 7 | 0.2032 | 1 | 8 | -0.1155 | 1 | 9 | -0.0600 | 1 | 10 | 0.0912 | 1 | 11 | -0.1070 | 1 | 12 | -0.2791 |
| 1 | 13 | 0.1014 | 1 | 14 | -0.0772 | 1 | 15 | 0.1065 | 1 | 16 | -0.2321 | 1 | 17 | -0.2166 | 1 | 18 | -0.1816 |
| 1 | 19 | 0.0644 | 1 | 20 | 0.2886 | | | | | | | | | | | | |
| 2 | 1 | 0.2350 | 2 | 2 | 1.0000 | 2 | 3 | -0.1698 | 2 | 4 | 0.2583 | 2 | 5 | -0.0436 | 2 | 6 | 0.0481 |
| 2 | 7 | -0.0089 | 2 | 8 | -0.0545 | 2 | 9 | -0.1620 | 2 | 10 | 0.1204 | 2 | 11 | 0.0066 | 2 | 12 | -0.0400 |
| 2 | 13 | 0.1509 | 2 | 14 | 0.2301 | 2 | 15 | -0.0532 | 2 | 16 | -0.0320 | 2 | 17 | -0.2374 | 2 | 18 | -0.2040 |
| 2 | 19 | 0.0974 | 2 | 20 | 0.2334 | | | | | | | | | | | | |
| 3 | 1 | 0.1189 | 3 | 2 | -0.1698 | 3 | 3 | 1.0000 | 3 | 4 | 0.0930 | 3 | 5 | 0.1255 | 3 | 6 | 0.3151 |
| 3 | 7 | 0.4551 | 3 | 8 | -0.1445 | 3 | 9 | 0.1059 | 3 | 10 | -0.1545 | 3 | 11 | 0.1089 | 3 | 12 | -0.4286 |
| 3 | 13 | 0.3193 | 3 | 14 | -0.0770 | 3 | 15 | 0.1167 | 3 | 16 | -0.2895 | 3 | 17 | -0.2881 | 3 | 18 | -0.4128 |
| 3 | 19 | 0.1911 | 3 | 20 | 0.2734 | | | | | | | | | | | | |
| 4 | 1 | -0.0557 | 4 | 2 | 0.2583 | 4 | 3 | 0.0930 | 4 | 4 | 1.0000 | 4 | 5 | 0.4310 | 4 | 6 | -0.0812 |
| 4 | 7 | 0.2800 | 4 | 8 | 0.0748 | 4 | 9 | 0.2308 | 4 | 10 | -0.0149 | 4 | 11 | -0.2591 | 4 | 12 | 0.0316 |
| 4 | 13 | -0.0289 | 4 | 14 | -0.1360 | 4 | 15 | -0.0857 | 4 | 16 | 0.1370 | 4 | 17 | -0.0502 | 4 | 18 | -0.1302 |
| 4 | 19 | 0.0161 | 4 | 20 | -0.0532 | | | | | | | | | | | | |
| 5 | 1 | -0.0267 | 5 | 2 | -0.0436 | 5 | 3 | 0.1255 | 5 | 4 | 0.4310 | 5 | 5 | 1.0000 | 5 | 6 | 0.0265 |
| 5 | 7 | 0.2818 | 5 | 8 | 0.1234 | 5 | 9 | 0.1090 | 5 | 10 | -0.2226 | 5 | 11 | -0.0800 | 5 | 12 | -0.1790 |
| 5 | 13 | -0.0462 | 5 | 14 | -0.2800 | 5 | 15 | 0.0755 | 5 | 16 | -0.0848 | 5 | 17 | -0.0110 | 5 | 18 | -0.1590 |
| 5 | 19 | 0.1097 | 5 | 20 | 0.0232 | | | | | | | | | | | | |
| 6 | 1 | 0.0107 | 6 | 2 | 0.0481 | 6 | 3 | 0.3151 | 6 | 4 | -0.0812 | 6 | 5 | 0.0265 | 6 | 6 | 1.0000 |
| 6 | 7 | 0.1817 | 6 | 8 | -0.2633 | 6 | 9 | -0.2732 | 6 | 10 | -0.0409 | 6 | 11 | 0.3250 | 6 | 12 | -0.3665 |
| 6 | 13 | 0.3323 | 6 | 14 | -0.0699 | 6 | 15 | 0.4377 | 6 | 16 | -0.4450 | 6 | 17 | -0.3224 | 6 | 18 | -0.2617 |
| 6 | 19 | 0.2425 | 6 | 20 | 0.1924 | | | | | | | | | | | | |
| 7 | 1 | 0.2032 | 7 | 2 | -0.0089 | 7 | 3 | 0.4551 | 7 | 4 | 0.2800 | 7 | 5 | 0.2818 | 7 | 6 | 0.1817 |
| 7 | 7 | 1.0000 | 7 | 8 | -0.0383 | 7 | 9 | 0.0096 | 7 | 10 | -0.1039 | 7 | 11 | -0.1597 | 7 | 12 | -0.3799 |
| 7 | 13 | 0.0455 | 7 | 14 | -0.2233 | 7 | 15 | 0.1399 | 7 | 16 | -0.1604 | 7 | 17 | -0.2810 | 7 | 18 | -0.3591 |
| 7 | 19 | 0.0864 | 7 | 20 | 0.1181 | | | | | | | | | | | | |
| 8 | 1 | -0.1155 | 8 | 2 | -0.0545 | 8 | 3 | -0.1445 | 8 | 4 | 0.0748 | 8 | 5 | 0.1234 | 8 | 6 | -0.2633 |
| 8 | 7 | -0.0383 | 8 | 8 | 1.0000 | 8 | 9 | 0.2599 | 8 | 10 | 0.0862 | 8 | 11 | -0.1627 | 8 | 12 | 0.2566 |
| 8 | 13 | -0.3779 | 8 | 14 | -0.0505 | 8 | 15 | -0.2701 | 8 | 16 | 0.3550 | 8 | 17 | 0.4797 | 8 | 18 | 0.4790 |
| 8 | 19 | -0.2272 | 8 | 20 | -0.4890 | | | | | | | | | | | | |
| 9 | 1 | -0.0600 | 9 | 2 | -0.1620 | 9 | 3 | 0.1059 | 9 | 4 | 0.2308 | 9 | 5 | 0.1090 | 9 | 6 | -0.2732 |
| 9 | 7 | 0.0096 | 9 | 8 | 0.2599 | 9 | 9 | 1.0000 | 9 | 10 | 0.0607 | 9 | 11 | -0.4164 | 9 | 12 | 0.3741 |
| 9 | 13 | -0.4010 | 9 | 14 | -0.0599 | 9 | 15 | -0.3670 | 9 | 16 | 0.5218 | 9 | 17 | 0.2914 | 9 | 18 | 0.0569 |
| 9 | 19 | -0.1098 | 9 | 20 | -0.5092 | | | | | | | | | | | | |
| 10 | 1 | 0.0912 | 10 | 2 | 0.1204 | 10 | 3 | -0.1545 | 10 | 4 | -0.0149 | 10 | 5 | -0.2226 | 10 | 6 | -0.0409 |
| 10 | 7 | -0.1039 | 10 | 8 | 0.0862 | 10 | 9 | 0.0607 | 10 | 10 | 1.0000 | 10 | 11 | -0.2375 | 10 | 12 | 0.1473 |
| 10 | 13 | 0.0015 | 10 | 14 | 0.2362 | 10 | 15 | -0.1567 | 10 | 16 | 0.2166 | 10 | 17 | 0.0028 | 10 | 18 | 0.0635 |
| 10 | 19 | -0.1234 | 10 | 20 | -0.0303 | | | | | | | | | | | | |

C.3./2

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 1 | ¯0.1070 | 11 | 2 | 0.0066 | 11 | 3 | 0.1089 | 11 | 4 | ¯0.2591 | 11 | 5 | ¯0.0800 | 11 | 6 | 0.3250 |
| 11 | 7 | ¯0.1597 | 11 | 8 | ¯0.1627 | 11 | 9 | ¯0.4164 | 11 | 10 | ¯0.2375 | 11 | 11 | 1.0000 | 11 | 12 | ¯0.4101 |
| 11 | 13 | 0.1629 | 11 | 14 | 0.0714 | 11 | 15 | 0.2608 | 11 | 16 | ¯0.4722 | 11 | 17 | ¯0.1770 | 11 | 18 | ¯0.1656 |
| 11 | 19 | 0.0718 | 11 | 20 | 0.3262 | | | | | | | | | | | | |
| 12 | 1 | ¯0.2791 | 12 | 2 | ¯0.0400 | 12 | 3 | ¯0.4286 | 12 | 4 | 0.0316 | 12 | 5 | ¯0.1790 | 12 | 6 | ¯0.3665 |
| 12 | 7 | ¯0.3799 | 12 | 8 | 0.2566 | 12 | 9 | 0.3741 | 12 | 10 | 0.1073 | 12 | 11 | ¯0.4101 | 12 | 12 | 1.0000 |
| 12 | 13 | ¯0.3976 | 12 | 14 | 0.2233 | 12 | 15 | ¯0.4017 | 12 | 16 | 0.5996 | 12 | 17 | 0.4005 | 12 | 18 | 0.5278 |
| 12 | 19 | ¯0.2855 | 12 | 20 | ¯0.4319 | | | | | | | | | | | | |
| 13 | 1 | 0.1014 | 13 | 2 | 0.1509 | 13 | 3 | 0.3193 | 13 | 4 | ¯0.0289 | 13 | 5 | ¯0.0462 | 13 | 6 | 0.3323 |
| 13 | 7 | 0.0455 | 13 | 8 | ¯0.3779 | 13 | 9 | ¯0.4010 | 13 | 10 | 0.0015 | 13 | 11 | 0.1629 | 13 | 12 | ¯0.3976 |
| 13 | 13 | 1.0000 | 13 | 14 | 0.1626 | 13 | 15 | 0.3357 | 13 | 16 | ¯0.3756 | 13 | 17 | ¯0.1584 | 13 | 18 | ¯0.2840 |
| 13 | 19 | 0.2407 | 13 | 20 | 0.5220 | | | | | | | | | | | | |
| 14 | 1 | ¯0.0772 | 14 | 2 | 0.2301 | 14 | 3 | ¯0.0770 | 14 | 4 | ¯0.1360 | 14 | 5 | ¯0.2800 | 14 | 6 | ¯0.0699 |
| 14 | 7 | ¯0.2233 | 14 | 8 | ¯0.0505 | 14 | 9 | ¯0.0599 | 14 | 10 | 0.2362 | 14 | 11 | 0.0714 | 14 | 12 | 0.2233 |
| 14 | 13 | 0.1626 | 14 | 14 | 1.0000 | 14 | 15 | ¯0.3183 | 14 | 16 | 0.1955 | 14 | 17 | 0.0767 | 14 | 18 | ¯0.0166 |
| 14 | 19 | 0.1414 | 14 | 20 | 0.2348 | | | | | | | | | | | | |
| 15 | 1 | 0.1065 | 15 | 2 | ¯0.0532 | 15 | 3 | 0.1187 | 15 | 4 | ¯0.0857 | 15 | 5 | 0.0755 | 15 | 6 | 0.4377 |
| 15 | 7 | 0.1399 | 15 | 8 | ¯0.2701 | 15 | 9 | ¯0.3670 | 15 | 10 | ¯0.1567 | 15 | 11 | 0.2608 | 15 | 12 | ¯0.4017 |
| 15 | 13 | 0.3357 | 15 | 14 | ¯0.3183 | 15 | 15 | 1.0000 | 15 | 16 | ¯0.4229 | 15 | 17 | ¯0.3421 | 15 | 18 | ¯0.1971 |
| 15 | 19 | 0.1026 | 15 | 20 | 0.4951 | | | | | | | | | | | | |
| 16 | 1 | ¯0.2321 | 16 | 2 | ¯0.0320 | 16 | 3 | ¯0.2895 | 16 | 4 | 0.1370 | 16 | 5 | ¯0.0848 | 16 | 6 | ¯0.4450 |
| 16 | 7 | ¯0.1604 | 16 | 8 | 0.3550 | 16 | 9 | 0.5218 | 16 | 10 | 0.2168 | 16 | 11 | ¯0.4722 | 16 | 12 | 0.5996 |
| 16 | 13 | ¯0.3756 | 16 | 14 | 0.1955 | 16 | 15 | ¯0.4229 | 16 | 16 | 1.0000 | 16 | 17 | 0.3908 | 16 | 18 | 0.4422 |
| 16 | 19 | ¯0.2458 | 16 | 20 | ¯0.3919 | | | | | | | | | | | | |
| 17 | 1 | ¯0.2166 | 17 | 2 | ¯0.2374 | 17 | 3 | ¯0.2881 | 17 | 4 | ¯0.0502 | 17 | 5 | ¯0.0110 | 17 | 6 | ¯0.3224 |
| 17 | 7 | ¯0.2810 | 17 | 8 | 0.4797 | 17 | 9 | 0.2914 | 17 | 10 | 0.0028 | 17 | 11 | ¯0.1770 | 17 | 12 | 0.4005 |
| 17 | 13 | ¯0.1584 | 17 | 14 | 0.0767 | 17 | 15 | ¯0.3421 | 17 | 16 | 0.3908 | 17 | 17 | 1.0000 | 17 | 18 | 0.6246 |
| 17 | 19 | ¯0.3129 | 17 | 20 | ¯0.3970 | | | | | | | | | | | | |
| 18 | 1 | ¯0.1816 | 18 | 2 | ¯0.2040 | 18 | 3 | ¯0.4128 | 18 | 4 | ¯0.1302 | 18 | 5 | ¯0.1590 | 18 | 6 | ¯0.2617 |
| 18 | 7 | ¯0.3591 | 18 | 8 | 0.4790 | 18 | 9 | 0.0569 | 18 | 10 | 0.0635 | 18 | 11 | ¯0.1656 | 18 | 12 | 0.5278 |
| 18 | 13 | ¯0.2840 | 18 | 14 | ¯0.0166 | 18 | 15 | ¯0.1971 | 18 | 16 | 0.4422 | 18 | 17 | 0.6246 | 18 | 18 | 1.0000 |
| 18 | 19 | ¯0.2269 | 18 | 20 | ¯0.5416 | | | | | | | | | | | | |
| 19 | 1 | 0.0644 | 19 | 2 | 0.0974 | 19 | 3 | 0.1911 | 19 | 4 | 0.0161 | 19 | 5 | 0.1097 | 19 | 6 | 0.2425 |
| 19 | 7 | 0.0864 | 19 | 8 | ¯0.2272 | 19 | 9 | ¯0.1098 | 19 | 10 | ¯0.1234 | 19 | 11 | 0.0718 | 19 | 12 | ¯0.2855 |
| 19 | 13 | 0.2407 | 19 | 14 | 0.1414 | 19 | 15 | 0.1026 | 19 | 16 | ¯0.2458 | 19 | 17 | ¯0.3129 | 19 | 18 | ¯0.2269 |
| 19 | 19 | 1.0000 | 19 | 20 | 0.0892 | | | | | | | | | | | | |
| 20 | 1 | 0.2886 | 20 | 2 | 0.2334 | 20 | 3 | 0.2734 | 20 | 4 | ¯0.0532 | 20 | 5 | 0.0232 | 20 | 6 | 0.1924 |
| 20 | 7 | 0.1181 | 20 | 8 | ¯0.4890 | 20 | 9 | ¯0.5092 | 20 | 10 | ¯0.0303 | 20 | 11 | 0.3262 | 20 | 12 | ¯0.4319 |
| 20 | 13 | 0.5220 | 20 | 14 | 0.2348 | 20 | 15 | 0.4951 | 20 | 16 | ¯0.3919 | 20 | 17 | ¯0.3970 | 20 | 18 | ¯0.5416 |
| 20 | 19 | 0.0892 | 20 | 20 | 1.0000 | | | | | | | | | | | | |

STEP NUMBER 1 ENTER VARIABLE 18
STANDARD ERROR OF ESTIMATE= 31.412
MULTIPLE CORRELATION COEFFICIENT = 0.542
GOODNESS OF FIT: 29.3280%
CONSTANT TERM= 236.6983

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 18 | -.1003E 02 | .2203E 01 | .2075E 02 | -.5416E 00 |

STEP NUMBER 2 ENTER VARIABLE 9
STANDARD ERROR OF ESTIMATE= 26.072
MULTIPLE CORRELATION COEFFICIENT = 0.723
GOODNESS OF FIT: 52.2854%
CONSTANT TERM= 292.2763

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 9 | -.9221E 01 | .1899E 01 | .2358E 02 | -.4799E 00 |
| 18 | -.9529E 01 | .1832E 01 | .2707E 02 | -.5143E 00 |

STEP NUMBER 3 ENTER VARIABLE 15
STANDARD ERROR OF ESTIMATE= 24.727
MULTIPLE CORRELATION COEFFICIENT = 0.761
GOODNESS OF FIT: 57.9599%
CONSTANT TERM= 252.4038

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 9 | -.7432E 01 | .1933E 01 | .1478E 02 | -.3868E 00 |
| 15 | .4403E 01 | .1730E 01 | .6479E 01 | .2608E 00 |
| 18 | -.8674E 01 | .1769E 01 | .2404E 02 | -.4681E 00 |

STEP NUMBER 4 ENTER VARIABLE 14
STANDARD ERROR OF ESTIMATE= 21.944
MULTIPLE CORRELATION COEFFICIENT = 0.822
GOODNESS OF FIT: 67.5778%
CONSTANT TERM= 182.1369

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 9 | -.6107E 01 | .1752E 01 | .1215E 02 | -.3178E 00 |
| 14 | .7355E 01 | .1970E 01 | .1394E 02 | .3353E 00 |
| 15 | .6727E 01 | .1657E 01 | .1649E 02 | .3985E 00 |
| 18 | -.8141E 01 | .1577E 01 | .2667E 02 | -.4393E 00 |

```
STEP NUMBER  5              ENTER VARIABLE  6
STANDARD ERROR OF ESTIMATE=      20.992
MULTIPLE CORRELATION COEFFICIENT = 0.842
GOODNESS OF FIT: 70.9623%
CONSTANT TERM=      203.6938
  VAR       COEFF        STD DEV     F-RATIO BETA COEFF
                           COEFF   VAR.CONTR
     6 -.4391E 01   .1897E 01   .5362E 01 -.2110E 00
     9 -.6617E 01   .1691E 01   .1532E 02 -.3444E 00
    14  .7524E 01   .1886E 01   .1592E 02  .3430E 00
    15  .8036E 01   .1682E 01   .2281E 02  .4761E 00
    18 -.8851E 01   .1539E 01   .3306E 02 -.4777E 00
```

```
STEP NUMBER  6              ENTER VARIABLE  3
STANDARD ERROR OF ESTIMATE=      20.101
MULTIPLE CORRELATION COEFFICIENT = 0.860
GOODNESS OF FIT: 73.9543%
CONSTANT TERM=      187.6618
  VAR       COEFF        STD DEV     F-RATIO BETA COEFF
                           COEFF   VAR.CONTR
     3  .3718E 01   .1635E 01   .5169E 01  .2007E 00
     6 -.5561E 01   .1887E 01   .8680E 01 -.2672E 00
     9 -.7352E 01   .1651E 01   .1983E 02 -.3826E 00
    14  .7784E 01   .1809E 01   .1851E 02  .3549E 00
    15  .8113E 01   .1611E 01   .2535E 02  .4807E 00
    18 -.7527E 01   .1584E 01   .2257E 02 -.4062E 00
```

```
STEP NUMBER  7              ENTER VARIABLE  1
STANDARD ERROR OF ESTIMATE=      19.416
MULTIPLE CORRELATION COEFFICIENT = 0.873
GOODNESS OF FIT: 76.2398%
CONSTANT TERM=      158.0364
  VAR       COEFF        STD DEV     F-RATIO BETA COEFF
                           COEFF   VAR.CONTR
     1  .4280E 01   .2080E 01   .4232E 01  .1554E 00
     3  .3483E 01   .1584E 01   .4838E 01  .1880E 00
     6 -.5205E 01   .1831E 01   .8080E 01 -.2502E 00
     9 -.7148E 01   .1598E 01   .2001E 02 -.3720E 00
    14  .8002E 01   .1751E 01   .2089E 02  .3648E 00
    15  .7935E 01   .1559E 01   .2591E 02  .4701E 00
    18 -.7065E 01   .1547E 01   .2086E 02 -.3813E 00
```

STEP NUMBER 8 ENTER VARIABLE 19
STANDARD ERROR OF ESTIMATE= 18.912
MULTIPLE CORRELATION COEFFICIENT = 0.883
GOODNESS OF FIT: 77.9681%
CONSTANT TERM= 173.9691

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | .4417E 01 | .2028E 01 | .4744E 01 | .1604E 00 |
| 3 | .3735E 01 | .1549E 01 | .5817E 01 | .2016E 00 |
| 6 | -.4720E 01 | .1803E 01 | .6852E 01 | -.2269E 00 |
| 9 | -.7271E 01 | .1558E 01 | .2179E 02 | -.3784E 00 |
| 14 | .8514E 01 | .1728E 01 | .2428E 02 | .3881E 00 |
| 15 | .7996E 01 | .1519E 01 | .2772E 02 | .4737E 00 |
| 18 | -.7394E 01 | .1517E 01 | .2375E 02 | -.3990E 00 |
| 19 | -.3217E 01 | .1751E 01 | .3373E 01 | -.1402E 00 |

STEP NUMBER 9 ENTER VARIABLE 8
STANDARD ERROR OF ESTIMATE= 18.547
MULTIPLE CORRELATION COEFFICIENT = 0.891
GOODNESS OF FIT: 79.3039%
CONSTANT TERM= 189.0817

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | .4336E 01 | .1989E 01 | .4751E 01 | .1575E 00 |
| 3 | .3904E 01 | .1522E 01 | .6579E 01 | .2108E 00 |
| 6 | -.4893E 01 | .1771E 01 | .7628E 01 | -.2351E 00 |
| 8 | -.3345E 01 | .2032E 01 | .2711E 01 | -.1393E 00 |
| 9 | -.6858E 01 | .1548E 01 | .1962E 02 | -.3569E 00 |
| 14 | .8332E 01 | .1698E 01 | .2407E 02 | .3798E 00 |
| 15 | .7721E 01 | .1499E 01 | .2653E 02 | .4574E 00 |
| 18 | -.6275E 01 | .1636E 01 | .1471E 02 | -.3386E 00 |
| 19 | -.3498E 01 | .1726E 01 | .4108E 01 | -.1525E 00 |

STEP NUMBER 10 ENTER VARIABLE 17
STANDARD ERROR OF ESTIMATE= 18.087
MULTIPLE CORRELATION COEFFICIENT = 0.899
GOODNESS OF FIT: 80.7857%
CONSTANT TERM= 178.6407

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | .4707E 01 | .1951E 01 | .5820E 01 | .1709E 00 |
| 3 | .4014E 01 | .1486E 01 | .7299E 01 | .2167E 00 |
| 6 | -.4791E 01 | .1729E 01 | .7683E 01 | -.2303E 00 |
| 8 | -.3935E 01 | .2009E 01 | .3836E 01 | -.1638E 00 |
| 9 | -.7469E 01 | .1548E 01 | .2327E 02 | -.3887E 00 |
| 14 | .7998E 01 | .1667E 01 | .2302E 02 | .3646E 00 |
| 15 | .7959E 01 | .1468E 01 | .2940E 02 | .4715E 00 |
| 17 | .3782E 01 | .2127E 01 | .3162E 01 | .1764E 00 |
| 18 | -.7799E 01 | .1811E 01 | .1854E 02 | -.4209E 00 |
| 19 | -.2925E 01 | .1714E 01 | .2913E 01 | -.1275E 00 |

STEP NUMBER 11 ENTER VARIABLE 16
STANDARD ERROR OF ESTIMATE= 17.504
MULTIPLE CORRELATION COEFFICIENT = 0.908
GOODNESS OF FIT: 82.4438%
CONSTANT TERM= 164.8749

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | .5400E 01 | .1921E 01 | .7697E 01 | .1961E 00 |
| 3 | .4497E 01 | .1459E 01 | .9500E 01 | .2428E 00 |
| 6 | -.4122E 01 | .1708E 01 | .5824E 01 | -.1981E 00 |
| 8 | -.4127E 01 | .1947E 01 | .4495E 01 | -.1718E 00 |
| 9 | -.9352E 01 | .1784E 01 | .2747E 02 | -.4867E 00 |
| 14 | .7043E 01 | .1686E 01 | .1744E 02 | .3211E 00 |
| 15 | .8102E 01 | .1422E 01 | .3244E 02 | .4800E 00 |
| 16 | .3586E 01 | .1845E 01 | .3778E 01 | .1999E 00 |
| 17 | .4540E 01 | .2095E 01 | .4696E 01 | .2118E 00 |
| 18 | -.9120E 01 | .1880E 01 | .2354E 02 | -.4922E 00 |
| 19 | -.2413E 01 | .1679E 01 | .2064E 01 | -.1052E 00 |

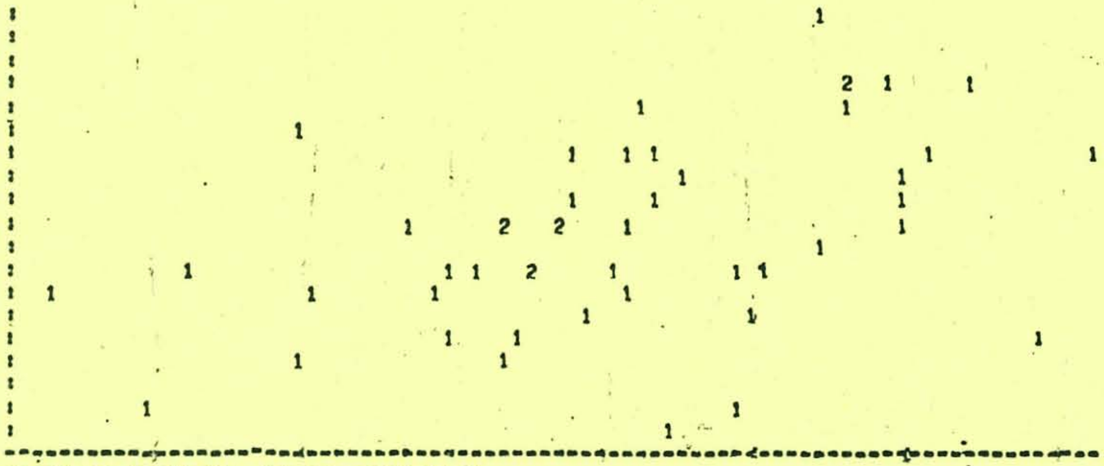
| OBS | ACTUAL | ESTIMATE | RESIDUAL |
|---|---|---|---|
| 1 | 173.00 | 177.06 | -4.06 |
| 2 | 161.00 | 176.40 | -15.40 |
| 3 | 115.00 | 139.30 | -24.30 |
| 4 | 159.00 | 166.26 | -7.26 |
| 5 | 169.00 | 166.72 | 2.28 |
| 6 | 179.00 | 176.88 | 2.12 |
| 7 | 193.00 | 181.21 | 11.79 |
| 8 | 196.00 | 186.63 | 9.37 |
| 9 | 219.00 | 184.01 | 34.99 |
| 10 | 223.00 | 199.44 | 23.56 |
| 11 | 230.00 | 220.33 | 9.67 |
| 12 | 235.00 | 222.33 | 12.67 |
| 13 | 121.00 | 126.09 | -5.09 |
| 14 | 162.00 | 164.71 | -2.71 |
| 15 | 172.00 | 185.61 | -13.61 |
| 16 | 199.00 | 230.80 | -31.80 |
| 17 | 241.00 | 215.62 | 25.38 |
| 18 | 101.00 | 109.73 | -8.73 |
| 19 | 138.00 | 121.12 | 16.88 |
| 20 | 139.00 | 159.29 | -20.29 |
| 21 | 142.00 | 174.45 | -32.45 |
| 22 | 155.00 | 152.37 | 2.63 |
| 23 | 169.00 | 166.68 | 2.32 |
| 24 | 174.00 | 177.42 | -3.42 |
| 25 | 190.00 | 169.94 | 20.06 |
| 26 | 193.00 | 186.62 | 6.38 |
| 27 | 195.00 | 225.24 | -30.24 |
| 28 | 205.00 | 229.24 | -24.24 |
| 29 | 210.00 | 214.38 | -4.38 |
| 30 | 218.00 | 218.74 | -0.74 |
| 31 | 259.00 | 246.75 | 12.25 |
| 32 | 95.00 | 101.58 | -6.58 |
| 33 | 140.00 | 149.02 | -9.02 |
| 34 | 163.00 | 155.67 | 7.33 |
| 35 | 165.00 | 168.08 | -3.08 |
| 36 | 170.00 | 186.90 | -16.90 |
| 37 | 178.00 | 174.00 | 4.00 |
| 38 | 180.00 | 164.69 | 15.31 |
| 39 | 181.00 | 173.30 | 7.70 |
| 40 | 182.00 | 191.94 | -9.94 |
| 41 | 187.00 | 192.26 | -5.26 |
| 42 | 188.00 | 195.26 | -7.26 |
| 43 | 188.00 | 174.12 | 13.88 |
| 44 | 189.00 | 187.49 | 1.51 |
| 45 | 205.00 | 209.63 | -4.63 |
| 46 | 207.00 | 220.04 | -13.04 |
| 47 | 222.00 | 198.48 | 23.52 |
| 48 | 223.00 | 201.61 | 21.39 |
| 49 | 228.00 | 204.06 | 23.94 |
| 50 | 231.00 | 223.18 | 7.82 |
| 51 | 231.00 | 229.39 | 1.61 |
| 52 | 251.00 | 266.92 | -15.92 |



C.3./8

APP. C.4.

PLOT AND HISTOGRAM OF RESIDUALS OF MLRA III.

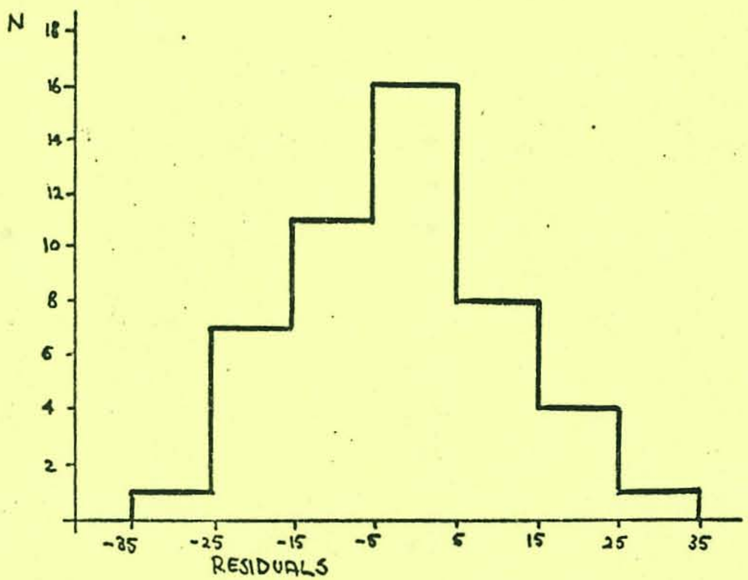


GRAPH OF VARIABLE 20 VS. RESIDUALS

X-AXIS BOUNDS ARE: 94.000000 260.000000 X INCREMENT = 2.101266

Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947

NO. OF OBSERVATIONS = 52




HISTOGRAM OF RESIDUALS

PERSONALITY CORRELATES TO PERFORMANCE UNDER STRESS H.P.LEHMANN

TRANSFORMED DATA: SECOND-STRATUM STEN/SCORES FOR 16/PF-VALUES

| | EXVIA | ANXIETY | CORTERTIA | INDEP. | DISCREET | PROD.S. | SUPEREGO | STATE/A. | TRAIT/A | RAVEN/INT | AGE | EXPERIENCE | SIM.SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.07 | | 3.89 | 4.60 | 7.01 | 4.84 | 5.23 | 5.00 | 7.00 | 8.00 | | | 173.00 |
| 2 | 8.25 | | 8.08 | 4.94 | 3.73 | 6.16 | 6.32 | 2.00 | 3.00 | 9.00 | | | 161.00 |
| 3 | 2.16 | | 2.07 | 3.45 | 7.50 | 4.75 | 4.79 | 7.00 | 8.00 | 7.00 | | | 115.00 |
| 4 | 4.63 | | 5.14 | 4.91 | 4.14 | 6.86 | 2.96 | 6.00 | 7.00 | 3.00 | | | 159.00 |
| 5 | 5.60 | | 8.13 | 7.88 | 4.64 | 8.50 | 4.29 | 3.00 | 4.00 | 7.00 | | | 169.00 |
| 6 | 5.37 | | 5.22 | 5.51 | 4.21 | 6.22 | 3.89 | 4.00 | 4.00 | 10.00 | | | 179.00 |
| 7 | 2.63 | | 4.25 | 4.72 | 7.20 | 6.10 | 7.11 | 4.00 | 6.00 | 5.00 | | | 193.00 |
| 8 | 6.49 | | 5.15 | 5.49 | 6.08 | 4.00 | 8.46 | 6.00 | 7.00 | 8.00 | | | 196.00 |
| 9 | 3.75 | | 6.48 | 5.30 | 5.83 | 6.45 | 4.36 | 6.00 | 6.00 | 6.00 | | | 219.00 |
| 10 | 5.73 | | 3.07 | 6.26 | 8.86 | 7.11 | 5.81 | 4.00 | 6.00 | 9.00 | | | 223.00 |
| 11 | 6.43 | | 6.13 | 6.12 | 3.35 | 2.94 | 6.65 | 1.00 | 3.00 | 9.00 | | | 230.00 |
| 12 | 2.63 | | 4.97 | 1.86 | 10.06 | 4.89 | 5.87 | 5.00 | 5.00 | 7.00 | | | 235.00 |
| 13 | 6.07 | | 4.96 | 5.20 | 6.07 | 3.50 | 5.31 | 7.00 | 7.00 | 6.00 | | | 121.00 |
| 14 | 4.09 | | 4.03 | 4.70 | 3.43 | 5.63 | 5.53 | 6.00 | 7.00 | 7.00 | | | 162.00 |
| 15 | 3.65 | | 6.61 | 6.11 | 6.97 | 6.05 | 8.10 | 6.00 | 5.00 | 7.00 | | | 172.00 |
| 16 | 3.71 | | 3.94 | 5.50 | 5.16 | 7.79 | 5.95 | 5.00 | 6.00 | 6.00 | | | 159.00 |
| 17 | 6.46 | | 7.14 | 6.92 | 4.00 | 3.99 | 6.44 | 5.00 | 3.00 | 9.00 | | | 241.00 |
| 18 | 6.82 | | 4.75 | 5.69 | 6.00 | 5.93 | 5.13 | 5.00 | 5.00 | 7.00 | | | 101.00 |
| 19 | 6.47 | | 5.34 | 5.41 | 4.00 | 7.50 | 3.91 | 6.00 | 7.00 | 5.00 | | | 138.00 |
| 20 | 4.39 | | 4.43 | 4.40 | 4.36 | 6.24 | 7.05 | 5.00 | 8.00 | 6.00 | | | 139.00 |
| 21 | 5.68 | | 5.01 | 5.69 | 3.17 | 6.82 | 4.48 | 6.00 | 6.00 | 6.00 | | | 142.00 |
| 22 | 5.14 | | 4.70 | 4.73 | 5.06 | 6.47 | 4.72 | 6.00 | 5.00 | 7.00 | | | 155.00 |
| 23 | 4.86 | | 3.90 | 5.37 | 4.25 | 6.25 | 2.76 | 8.00 | 4.00 | 6.00 | | | 169.00 |
| 24 | 7.98 | | 6.76 | 5.33 | 4.73 | 6.78 | 6.35 | 8.00 | 6.00 | 4.00 | | | 174.00 |
| 25 | 6.60 | | 4.66 | 7.37 | 3.96 | 6.27 | 2.99 | 7.00 | 5.00 | 6.00 | | | 190.00 |
| 26 | 4.17 | | 6.01 | 6.47 | 6.90 | 5.62 | 4.01 | 5.00 | 2.00 | 6.00 | | | 193.00 |
| 27 | 5.62 | | 5.11 | 7.36 | 8.05 | 3.55 | 6.63 | 5.00 | 2.00 | 7.00 | | | 195.00 |
| 28 | 7.01 | | 6.73 | 7.23 | 1.28 | 2.84 | 3.32 | 3.00 | 1.00 | 6.00 | | | 205.00 |
| 29 | 6.29 | | 2.74 | 5.92 | 5.14 | 5.81 | 6.55 | 6.00 | 7.00 | 5.00 | | | 210.00 |
| 30 | 6.37 | | 5.21 | 4.84 | 5.99 | 2.73 | 5.51 | 5.00 | 7.00 | 5.00 | | | 218.00 |
| 31 | 5.27 | | 4.01 | 6.66 | 7.09 | 6.45 | 9.69 | 2.00 | 1.00 | 7.00 | | | 259.00 |
| 32 | 6.98 | | 5.60 | 5.66 | 1.09 | 5.83 | 5.34 | 5.00 | 8.00 | 9.00 | | | 95.00 |
| 33 | 4.23 | | 6.15 | 7.23 | 4.06 | 5.85 | 5.00 | 7.00 | 7.00 | 9.00 | | | 140.00 |
| 34 | 3.82 | | 5.46 | 5.34 | 7.82 | 7.50 | 3.16 | 3.00 | 5.00 | 7.00 | | | 163.00 |
| 35 | 4.73 | | 5.75 | 6.40 | 5.99 | 5.70 | 5.46 | 3.00 | 5.00 | 6.00 | | | 165.00 |
| 36 | 2.45 | | 5.39 | 5.40 | 3.38 | 5.80 | 3.46 | 7.00 | 5.00 | 6.00 | | | 170.00 |
| 37 | 6.11 | | 5.52 | 5.61 | 5.67 | 7.68 | 5.22 | 7.00 | 5.00 | 6.00 | | | 178.00 |
| 38 | 3.31 | | 4.10 | 5.65 | 2.39 | 5.33 | 3.23 | 6.00 | 7.00 | 7.00 | | | 180.00 |
| 39 | 2.27 | | 4.65 | 4.09 | 6.10 | 8.04 | 5.44 | 8.00 | 9.00 | 4.00 | | | 181.00 |
| 40 | 5.05 | | 3.86 | 3.40 | 8.19 | 5.32 | 7.07 | 4.00 | 3.00 | 5.00 | | | 182.00 |
| 41 | 2.39 | | 6.75 | 4.42 | 6.05 | 6.82 | 2.08 | 7.00 | 8.00 | 8.00 | | | 187.00 |
| 42 | 4.37 | | 4.77 | 7.03 | 3.35 | 6.82 | 6.51 | 4.00 | 5.00 | 6.00 | | | 188.00 |
| 43 | 5.54 | | 5.93 | 5.87 | 5.89 | 5.38 | 3.41 | 4.00 | 6.00 | 3.00 | | | 188.00 |
| 44 | 6.53 | | 6.73 | 7.95 | 5.67 | 8.15 | 3.93 | 7.00 | 6.00 | 9.00 | | | 189.00 |
| 45 | 3.72 | | 3.45 | 6.48 | 4.35 | 5.67 | 4.79 | 5.00 | 5.00 | 7.00 | | | 205.00 |
| 46 | 5.65 | | 4.88 | 5.15 | 6.96 | 5.26 | 7.46 | 2.00 | 3.00 | 9.00 | | | 207.00 |
| 47 | 4.47 | | 4.43 | 5.36 | 7.09 | 5.23 | 6.47 | 6.00 | 5.00 | 8.00 | | | 222.00 |
| 48 | 7.15 | | 5.41 | 6.13 | 4.13 | 2.77 | 5.79 | 5.00 | 3.00 | 6.00 | | | 223.00 |
| 49 | 3.89 | | 4.61 | 4.52 | 9.06 | 4.17 | 6.04 | 3.00 | 4.00 | 7.00 | | | 228.00 |
| 50 | 7.56 | | 7.76 | 8.96 | 2.78 | 7.89 | 3.92 | 5.00 | 4.00 | 5.00 | | | 231.00 |
| 51 | 5.04 | | 3.61 | 5.19 | 8.15 | 2.98 | 8.05 | 3.00 | 2.00 | 7.00 | | | 231.00 |
| 52 | 5.17 | | 7.39 | 6.83 | 8.82 | 3.75 | 6.02 | 2.00 | 1.00 | 9.00 | | | 251.00 |



APP.C.5. MLRA IV
TRANSFORMED DATA MATRIX

STEP NUMBER 9 ENTER VARIABLE 2
STANDARD ERROR OF ESTIMATE= 31.089
MULTIPLE CORRELATION COEFFICIENT = 0.647
GOODNESS OF FIT: 41.8487%
CONSTANT TERM= 191.5354

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 1 | -.4434E 01 | .3608E 01 | .1511E 01 | -.1830E 00 |
| 2 | .1618E 01 | .4001E 01 | .1635E 00 | .5794E-01 |
| 3 | .7729E 01 | .4778E 01 | .2617E 01 | .2599E 00 |
| 4 | .4498E 01 | .2812E 01 | .2558E 01 | .2406E 00 |
| 5 | -.3677E 01 | .3386E 01 | .1179E 01 | -.1497E 00 |
| 6 | .3214E 01 | .3295E 01 | .9510E 00 | .1421E 00 |
| 7 | -.1444E 01 | .3456E 01 | .1747E 00 | -.6738E-01 |
| 8 | -.6356E 01 | .3315E 01 | .3676E 01 | -.3430E 00 |
| 9 | -.2481E 01 | .2910E 01 | .7270E 00 | -.1082E 00 |

STEP NUMBER 2 ENTER VARIABLE 4
STANDARD ERROR OF ESTIMATE= 30.392
MULTIPLE CORRELATION COEFFICIENT = 0.593
GOODNESS OF FIT: 35.1642%
CONSTANT TERM= 208.1580

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF |
|---|---|---|---|---|
| 4 | .4570E 01 | .2176E 01 | .4411E 01 | .2445E 00 |
| 8 | -.9339E 01 | .2157E 01 | .1874E 02 | -.5040E 00 |



APP. C.5./2
MLRA IV - RESULTS
(F-LEVELS TO N = 19)

APPENDIX D

D.1. Scattergram of residuals (MLRA III) - investigation for curvatures

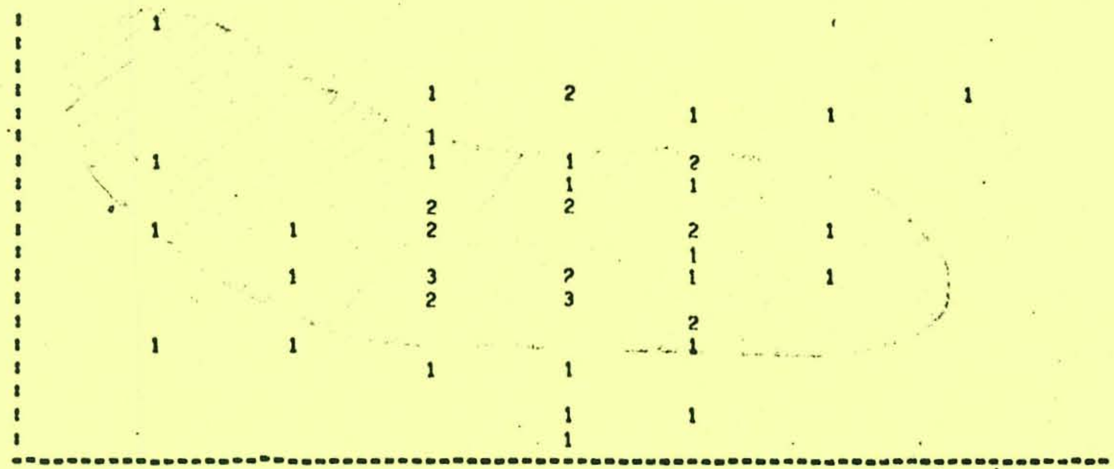
D.2. MQRA I - Results

D.3. MQRA II - Results

D.4. MQRA III - Results of both subsets

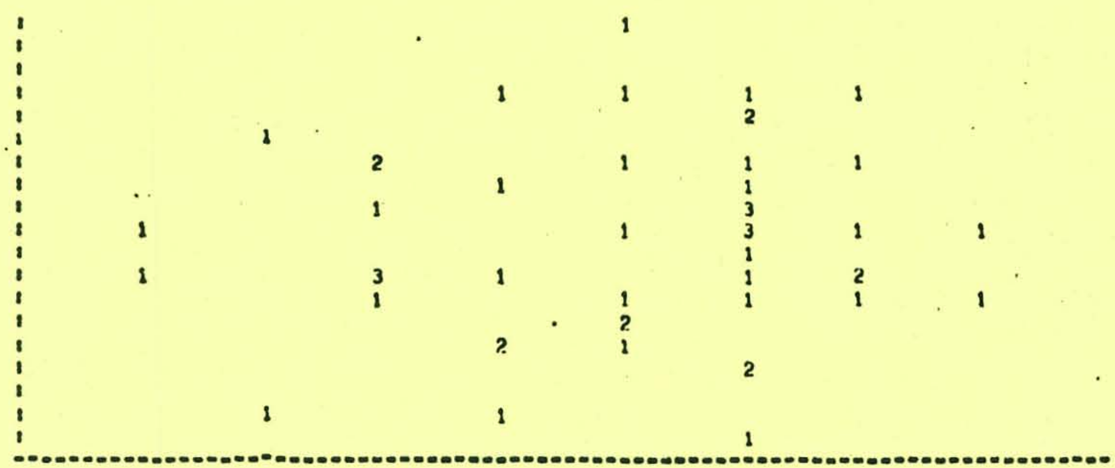
D.5. MQRA IV - Results

APP. D.1.
SCATERGRAM OF RESIDUALS
(HCRA III)
INVESTIGATION FOR
CURVATURES



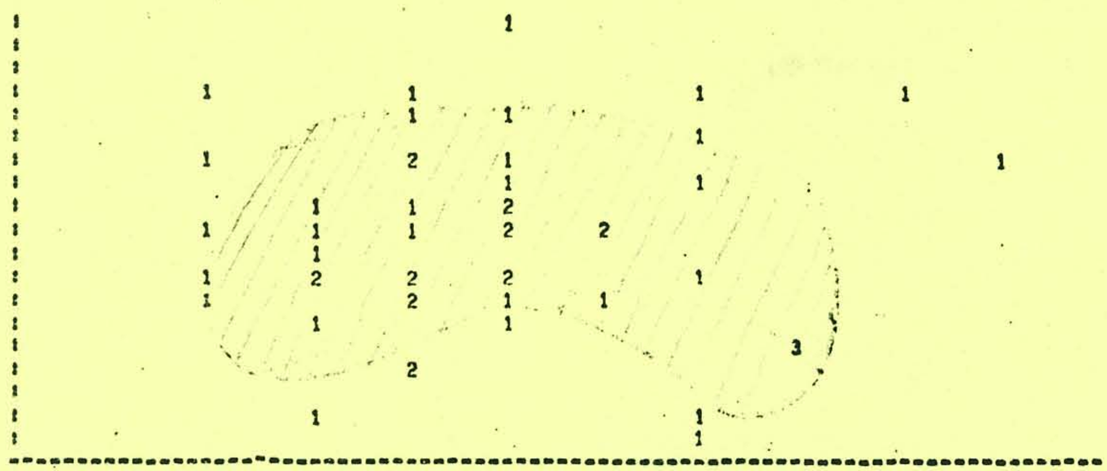
GRAPH OF VARIABLE 1 VS. RESIDUALS

X-AXIS BOUNDS ARE: 2.000000 10.000000 X INCREMENT = 0.101266
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



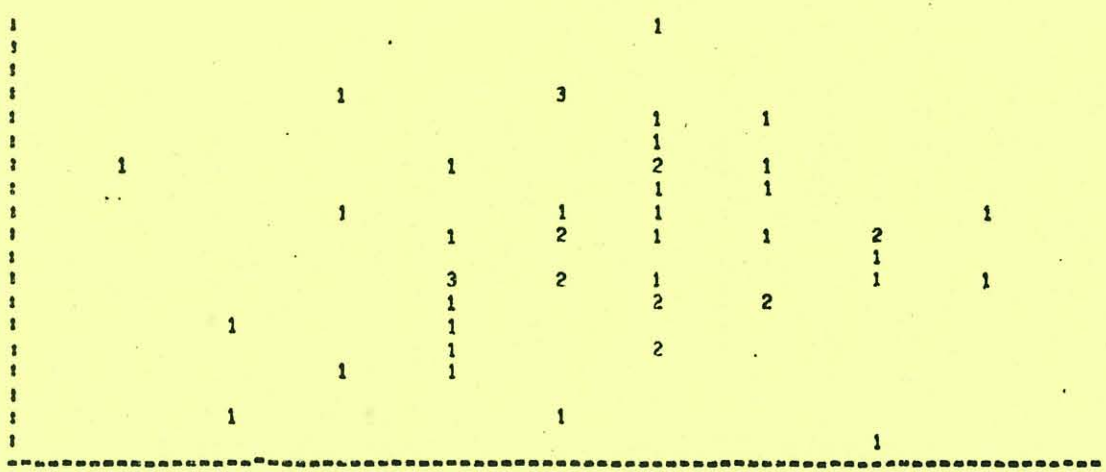
GRAPH OF VARIABLE 2 VS. RESIDUALS

X-AXIS BOUNDS ARE: 2.000000 11.000000 X INCREMENT = 0.113924
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



GRAPH OF VARIABLE 3 VS. RESIDUALS

X-AXIS BOUNDS ARE: 0.000000 11.000000 X INCREMENT = 0.139241
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52

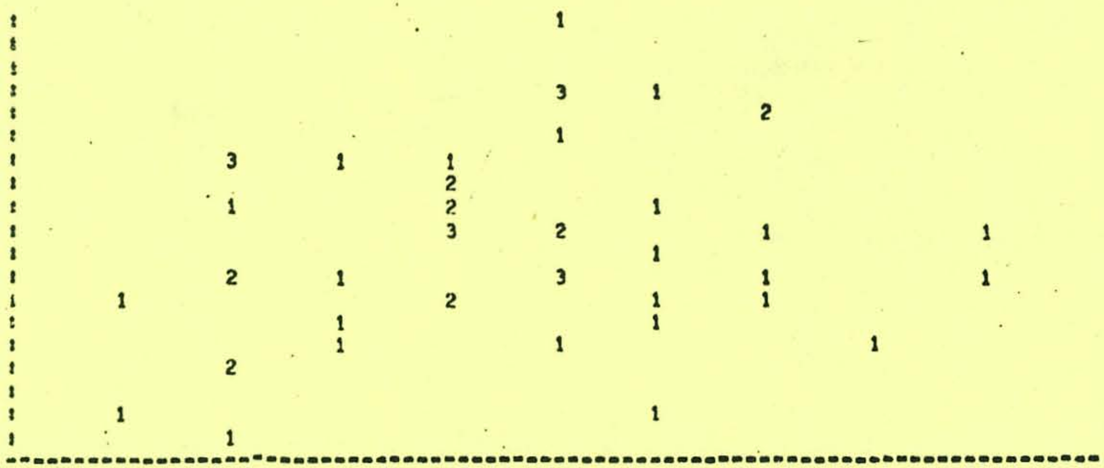


GRAPH OF VARIABLE 4 VS. RESIDUALS

X-AXIS BOUNDS ARE: 0.000000 10.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52

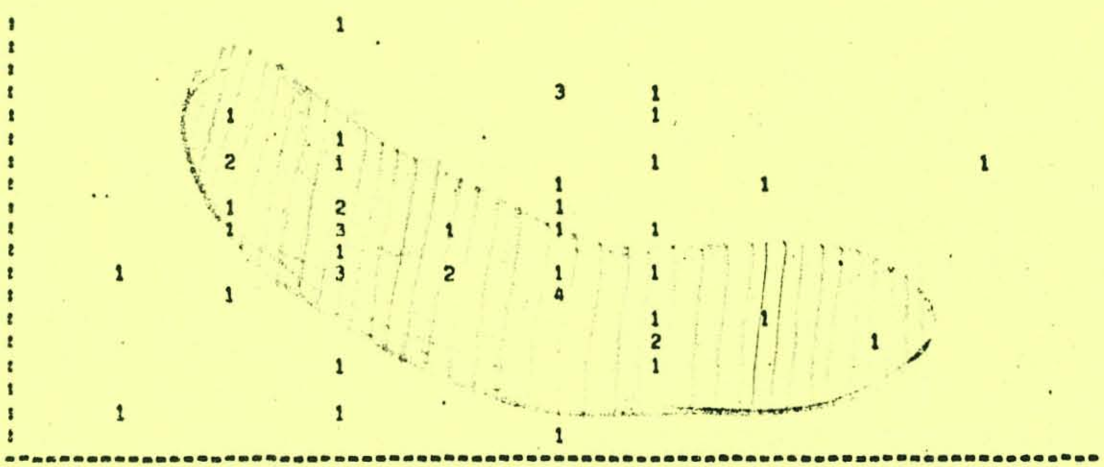


D.I./2



GRAPH OF VARIABLE 5 VS. RESIDUALS

X-AXIS BOUNDS ARE: 1.000000 11.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52

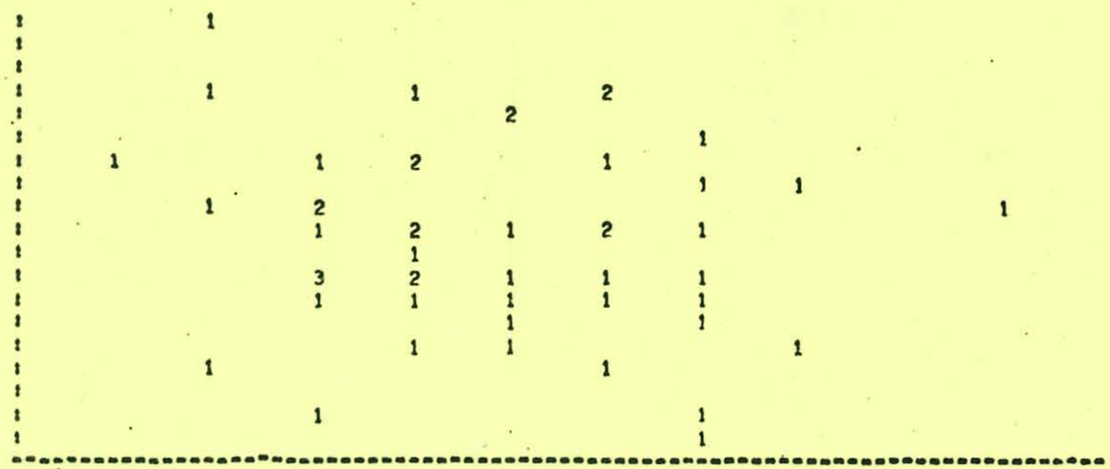


GRAPH OF VARIABLE 6 VS. RESIDUALS

X-AXIS BOUNDS ARE: 1.000000 11.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52

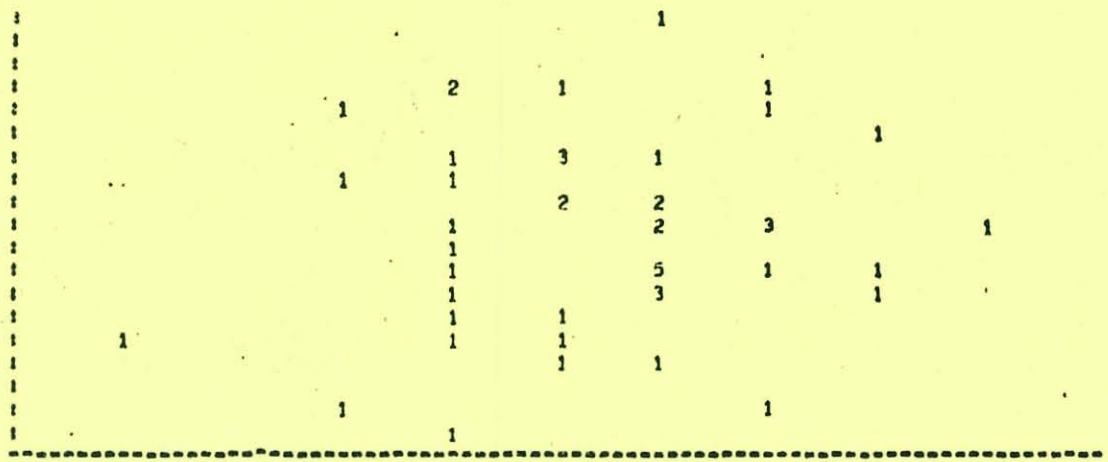


D.1./3



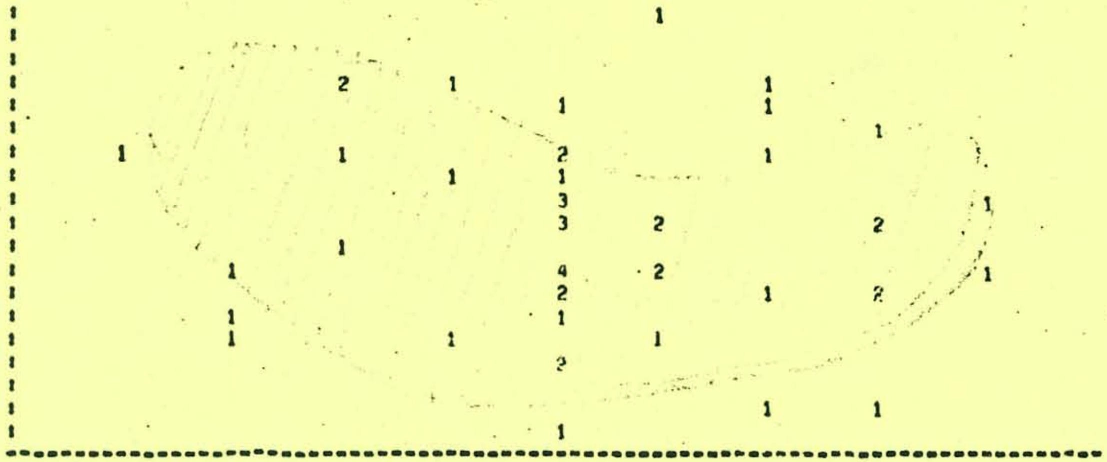
GRAPH OF VARIABLE 7 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:   0.000000     11.000000     X INCREMENT =   0.139241
Y-AXIS BOUNDS ARE: -33.000000     35.000000     Y INCREMENT =   3.578947
NO. OF OBSERVATIONS =   52
```



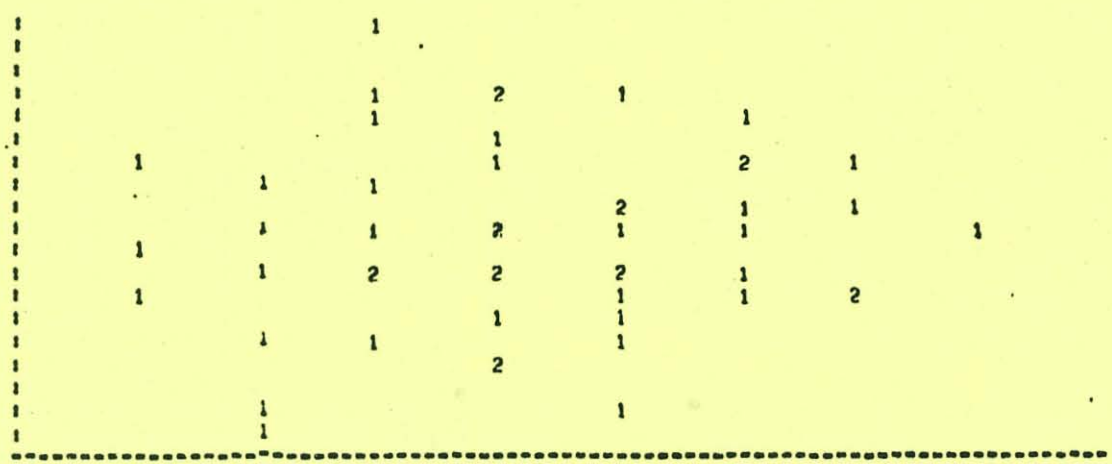
GRAPH OF VARIABLE 8 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:   0.000000     10.000000     X INCREMENT =   0.126582
Y-AXIS BOUNDS ARE: -33.000000     35.000000     Y INCREMENT =   3.578947
NO. OF OBSERVATIONS =   52
```



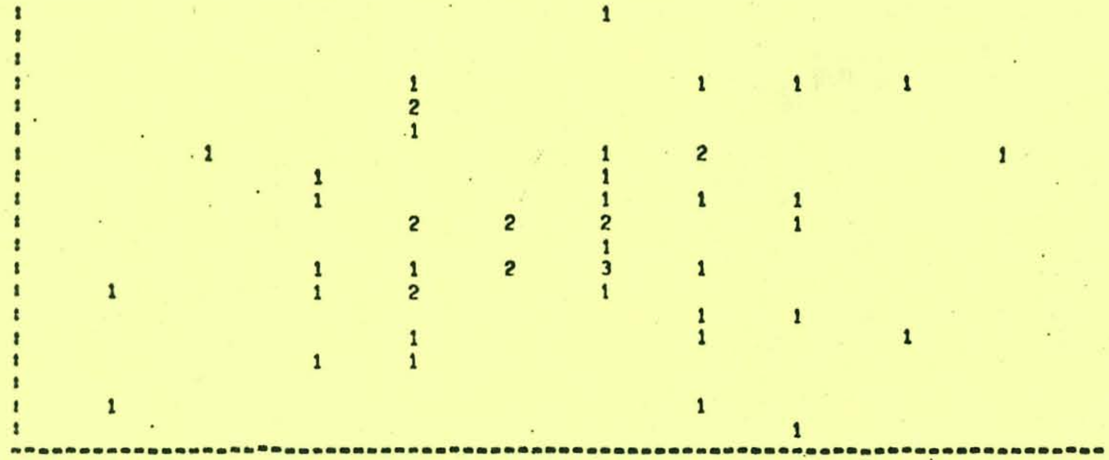
GRAPH OF VARIABLE 9 VS. RESIDUALS

X-AXIS BOUNDS ARE: 1.000000 11.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



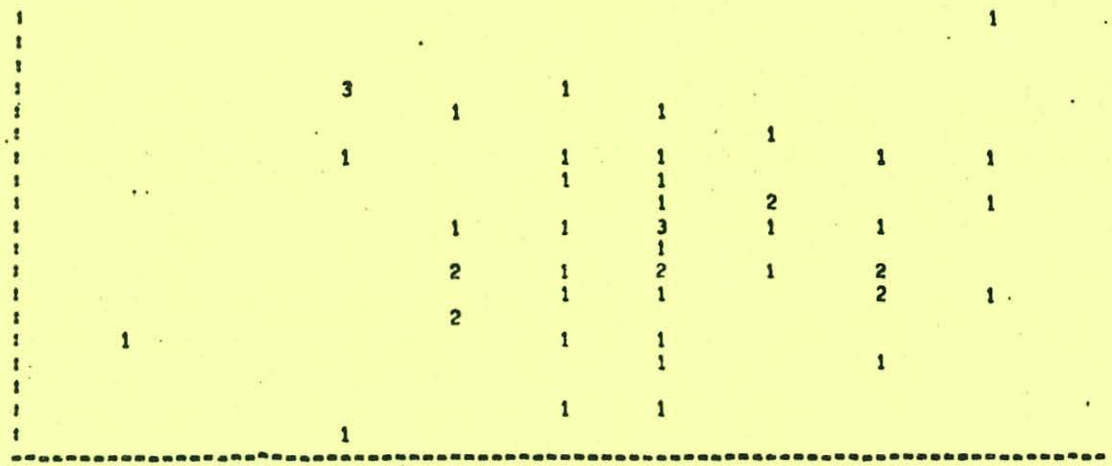
GRAPH OF VARIABLE 10 VS. RESIDUALS

X-AXIS BOUNDS ARE: 1.000000 10.000000 X INCREMENT = 0.113924
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



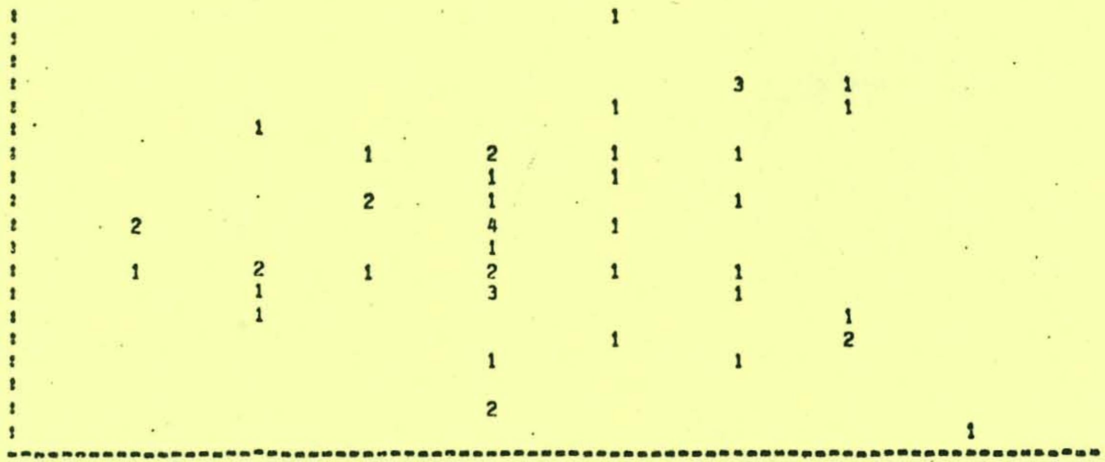
GRAPH OF VARIABLE 11 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:    0.000000     11.000000     X INCREMENT =    0.139241
Y-AXIS BOUNDS ARE:  -33.000000     35.000000     Y INCREMENT =    3.578947
NO. OF OBSERVATIONS =   52
```



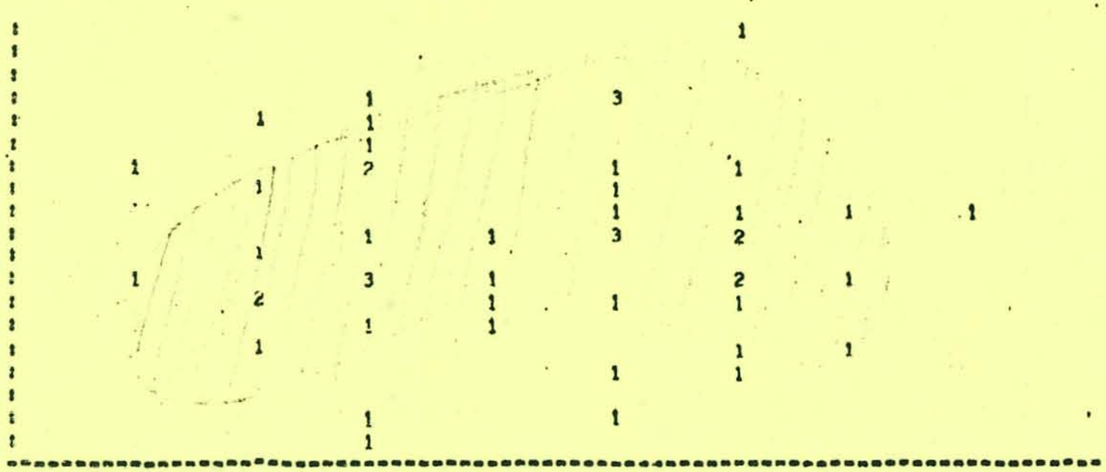
GRAPH OF VARIABLE 12 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:    0.000000     10.000000     X INCREMENT =    0.126582
Y-AXIS BOUNDS ARE:  -33.000000     35.000000     Y INCREMENT =    3.578947
NO. OF OBSERVATIONS =   52
```



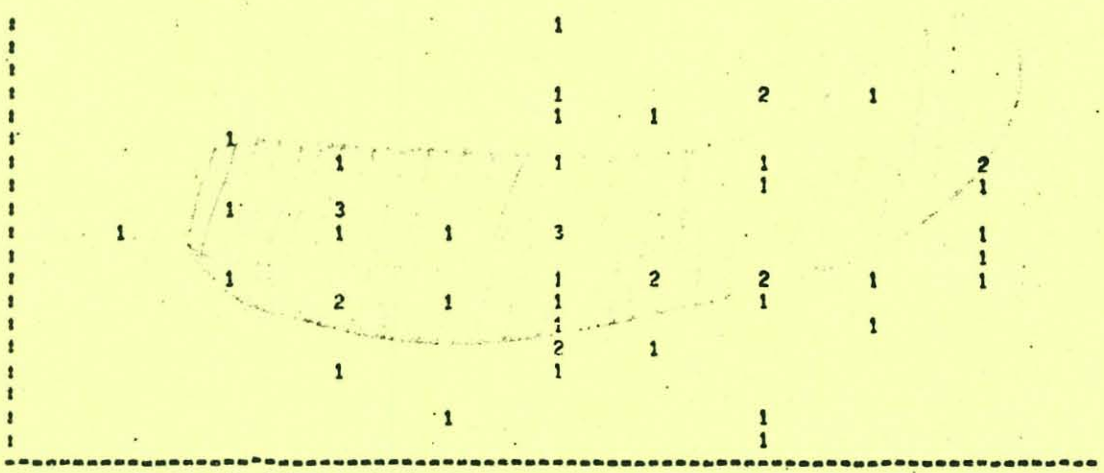
GRAPH OF VARIABLE 13 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:      1.000000      10.000000     X INCREMENT =     0.113924
Y-AXIS BOUNDS ARE:    -33.000000      35.000000     Y INCREMENT =     3.578947
NO. OF OBSERVATIONS =     52
```



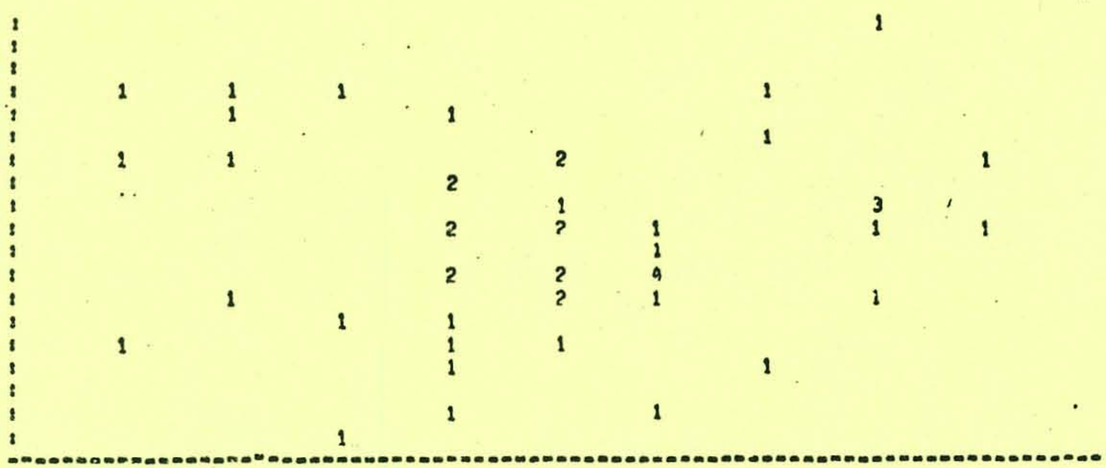
GRAPH OF VARIABLE 14 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:      2.000000      11.000000     X INCREMENT =     0.113924
Y-AXIS BOUNDS ARE:    -33.000000      35.000000     Y INCREMENT =     3.578947
NO. OF OBSERVATIONS =     52
```



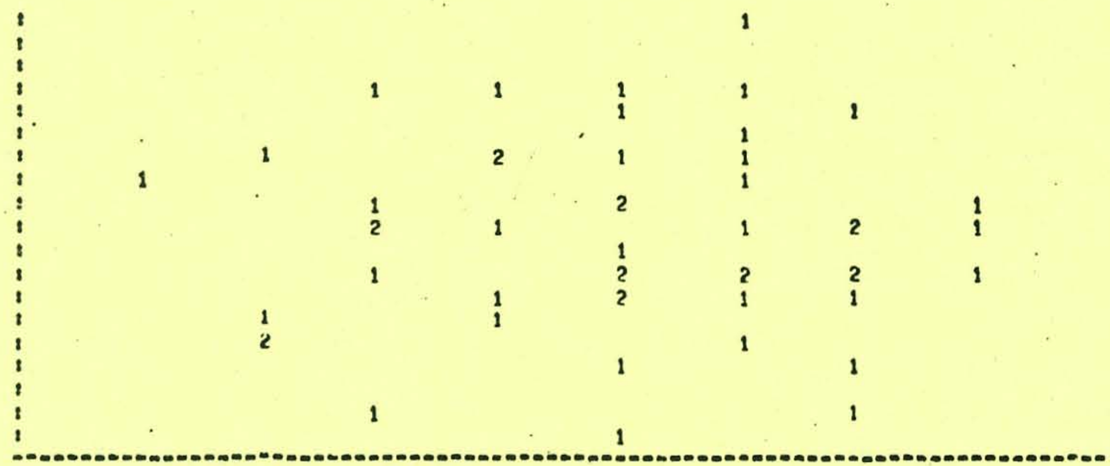
GRAPH OF VARIABLE 15 VS. RESIDUALS

X-AXIS BOUNDS ARE: 0.000000 10.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



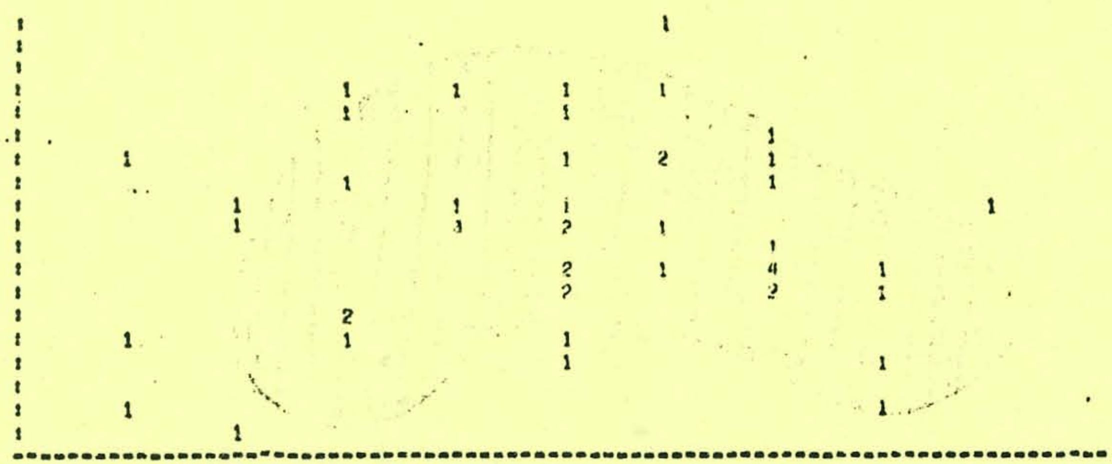
GRAPH OF VARIABLE 16 VS. RESIDUALS

X-AXIS BOUNDS ARE: 1.000000 11.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



GRAPH OF VARIABLE 17 VS. RESIDUALS

X-AXIS BOUNDS ARE: 0.000000 9.000000 X INCREMENT = 0.113924
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52

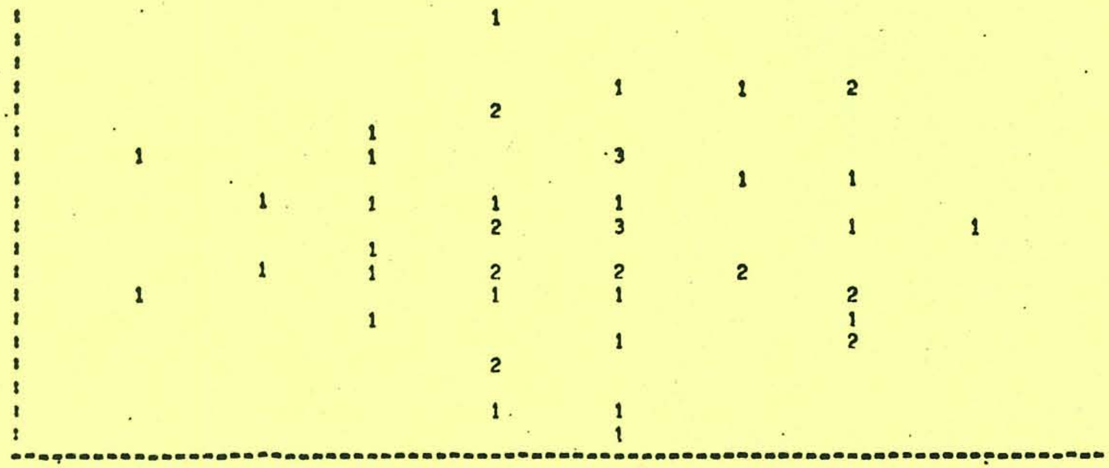


GRAPH OF VARIABLE 18 VS. RESIDUALS

X-AXIS BOUNDS ARE: 0.000000 10.000000 X INCREMENT = 0.126582
Y-AXIS BOUNDS ARE: -33.000000 35.000000 Y INCREMENT = 3.578947
NO. OF OBSERVATIONS = 52



D.1./9



GRAPH OF VARIABLE 19 VS. RESIDUALS

```
X-AXIS BOUNDS ARE:    2.000000      11.000000     X INCREMENT =    0.113924
Y-AXIS BOUNDS ARE:  -33.000000      35.000000     Y INCREMENT =    3.578947
NO. OF OBSERVATIONS =    52
```

STEP NUMBER 27          ENTER VARIABLE 17
STANDARD ERROR OF ESTIMATE=     19.705
MULTIPLE CORRELATION COEFFICIENT = 0.931
GOODNESS OF FIT: 86.6504%
CONSTANT TERM=    -219.8912

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF | VAR. DESCR.: |
|---|---|---|---|---|---|
| 1 | .1896E 02 | .3665E 02 | .2676E 00 | .6887E 00 | A |
| 2 | .4322E 02 | .3838E 02 | .1268E 01 | .2333E 01 | C |
| 3 | .3140E 02 | .3174E 02 | .9783E 00 | .1634E 01 | L |
| 4 | .4436E 02 | .4318E 02 | .1056E 01 | .2022E 01 | Q2 |
| 5 | .5422E 02 | .2712E 02 | .3998E 01 | .3212E 01 | Q3 |
| 6 | .4824E 02 | .3630E 02 | .1767E 01 | .2604E 01 | A-T |
| 7 | .2247E 01 | .2014E 01 | .1245E 01 | .9346E 00 | $A^2$ |
| 8 | -.1815E 01 | .1171E 01 | .2403E 01 | -.1063E 01 | $C^2$ |
| 9 | -.3765E 00 | .1319E 01 | .8149E-01 | -.2443E 00 | $L^2$ |
| 10 | .1472E 01 | .1513E 01 | .9471E 00 | .8500E 00 | $Q2^2$ |
| 11 | .5716E 00 | .1283E 01 | .1987E 00 | .3827E 00 | $Q3^2$ |
| 12 | -.1298E 01 | .1403E 01 | .8568E 00 | -.6879E 00 | $A\text{-}T^2$ |
| 13 | .7840E 00 | .1490E 01 | .2770E 00 | .3237E 00 | A×C |
| 14 | -.1215E 01 | .1808E 01 | .4513E 00 | -.4446E 00 | A×L |
| 15 | -.4097E 01 | .2645E 01 | .2400E 01 | -.1367E 01 | A×Q2 |
| 16 | -.2705E 01 | .2047E 01 | .1746E 01 | -.1192E 01 | A×Q3 |
| 17 | .1169E 01 | .2481E 01 | .2220E 00 | .4108E 00 | A×A-T |
| 18 | -.1333E 01 | .2150E 01 | .3847E 00 | -.5524E 00 | C×L |
| 19 | -.1421E 01 | .1999E 01 | .5055E 00 | -.5704E 00 | C×Q2 |
| 20 | -.1011E 01 | .1608E 01 | .3949E 00 | -.4648E 00 | C×Q3 |
| 21 | -.7402E 00 | .1563E 01 | .2243E 00 | -.2392E 00 | C×A-T |
| 22 | -.6286E 00 | .1687E 01 | .1368E 00 | -.2703E 00 | L×Q2 |
| 23 | -.9735E 00 | .1343E 01 | .5252E 00 | -.3949E 00 | L×Q3 |
| 24 | -.2060E 01 | .1460E 01 | .1992E 01 | -.9351E 00 | L×A-T |
| 25 | -.1604E 01 | .1644E 01 | .9524E 00 | -.6144E 00 | Q2×Q3 |
| 26 | -.2365E 01 | .1830E 01 | .1669E 01 | -.1020E 01 | Q2×A-T |
| 27 | -.3185E 01 | .1497E 01 | .4524E 01 | -.1310E 01 | Q3×A-T |

STEP NUMBER 7 DELETE VARIABLE 18
STANDARD ERROR OF ESTIMATE= 18.679
MULTIPLE CORRELATION COEFFICIENT = 0.878
GOODNESS OF FIT: 77.0079%
CONSTANT TERM= 118.2649

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF | VAR. DESCR.: |
|---|---|---|---|---|---|
| 5 | .1575E 02 | .4337E 01 | .1319E 02 | .9333E 00 | Q3 |
| 10 | .1189E 01 | .2951E 00 | .1623E 02 | .6865E 00 | $Q2^2$ |
| 13 | .5693E 00 | .1791E 00 | .1010E 02 | .2350E 00 | A×C |
| 24 | -.1135E 01 | .1758E 00 | .4168E 02 | -.5152E 00 | L×A-T |
| 25 | -.1474E 01 | .6534E 00 | .5089E 01 | -.5646E 00 | Q2×Q3 |



APP. D.3. RESULTS OF MQRA II

STEP NUMBER 9 ENTER VARIABLE 9
STANDARD ERROR OF ESTIMATE= 34.007
MULTIPLE CORRELATION COEFFICIENT = 0.552
GOODNESS OF FIT: 30.4201%
CONSTANT TERM= 179.6998

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF | VAR. DESCR.: |
|---|---|---|---|---|---|
| 1 | -.1666E 02 | .2873E 02 | .3364E 00 | -.6052E 00 | A |
| 2 | -.9829E 01 | .2030E 02 | .2345E 00 | -.5306E 00 | C |
| 3 | .6605E 01 | .2434E 02 | .7362E-01 | .3011E 00 | Q2 |
| 4 | .2774E 01 | .2181E 01 | .1618E 01 | .1154E 01 | $A^2$ |
| 5 | .3320E 00 | .1066E 01 | .9695E-01 | .1945E 00 | $C^2$ |
| 6 | .1173E 01 | .1613E 01 | .5287E 00 | .6771E 00 | $Q2^2$ |
| 7 | .1802E 01 | .1777E 01 | .1028E 01 | .7440E 00 | A×C |
| 8 | -.2649E 01 | .2387E 01 | .1232E 01 | -.8839E 00 | A×Q2 |
| 9 | -.1233E 00 | .1699E 01 | .5264E-02 | -.4948E-01 | C×Q2 |



APP. D.4.
RESULTS OF MQRA III
SUBSET: 16 PF-A
16 PF-C
16 PF-Q2

STEP NUMBER 9 ENTER VARIABLE 3
STANDARD ERROR OF ESTIMATE= 24.577
MULTIPLE CORRELATION COEFFICIENT = 0.798
GOODNESS OF FIT: 63.6594%
CONSTANT TERM= 217.3154

| VAR | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF | VAR. DESCR.: |
|---|---|---|---|---|---|
| 1 | .7748E 01 | .1497E 02 | .2678E 00 | .4032E 00 | L |
| 2 | -.6948E 01 | .1448E 02 | .2304E 00 | -.4116E 00 | Q3 |
| 3 | -.2409E 01 | .1336E 02 | .3248E-01 | -.1300E 00 | A-T |
| 4 | -.8716E 00 | .8710E 00 | .1001E 01 | -.5655E 00 | $L^2$ |
| 5 | .1022E 01 | .8667E 00 | .1392E 01 | .6845E 00 | $Q3^2$ |
| 6 | .3536E 00 | .9338E 00 | .1434E 00 | .1873E 00 | $A\text{-}T^2$ |
| 7 | .3343E 00 | .9105E 00 | .1348E 00 | .1356E 00 | L × Q3 |
| 8 | -.1258E 01 | .8585E 00 | .2147E 01 | -.5709E 00 | L × A-T |
| 9 | -.3316E 00 | .9201E 00 | .1298E 00 | -.1363E 00 | Q3 × A-T |



APP. D.4.
RESULTS OF MSRA III
SUBSET: 16 PF - L
16 PF - Q3
A-TRAIT

/2

NSTEP NUMBER14          ENTER VARIABLE  7  SQUARE:SELF CONCEPT CONTROL
STANDARD ERROR OF ESTIMATE=     20.818
MULTIPLE CORRELATION COEFFICIENT = 0.878
GOODNESS OF FIT: 77.0299%
CONSTANT TERM=     -145.9194

| | VARIABLE | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF | VAR DESCR. |
|---|---|---|---|---|---|---|
| 1 | ALAXIA-PROTENSION(TRUSTING/SP) | .2659E 02 | .2585E 02 | .1057E 01 | .1384E 01 | L |
| 2 | GROUP ADHERENT-SELF-SUFFICIENT | .1666E 02 | .2464E 02 | .4569E 00 | .7594E 00 | Q2 |
| 3 | SELF CONCEPT CONTROL | .4140E 02 | .2197E 02 | .3551E 01 | .2453E 01 | Q3 |
| 4 | TRAIT-ANXIETY (STAI) | .3158E 02 | .1980E 02 | .2545E 01 | .1704E 01 | A-T |
| 5 | SQUARE:ALAXIA | -.1543F 01 | .9624E 00 | .2569E 01 | -.1001E 01 | $L^2$ |
| 6 | SQUARE:GROUP ADHERENCE | .1064E 01 | .1239E 01 | .7372E 00 | .6141E 00 | $Q2^2$ |
| 7 | SQUARE:SELF CONCEPT CONTROL | .3796E-01 | .8226E 00 | .2130E-02 | .2542E-01 | $Q3^2$ |
| 8 | SQUARE:TRAIT ANXIETY | -.5944E 00 | .8796E 00 | .4567E 00 | -.3150E 00 | $A\text{-}T^2$ |
| 9 | CRP:ALAXIA X GROUP ADH. | .1811E 00 | .1335E 01 | .1840E-01 | .7787E-01 | L×Q2 |
| 10 | CRP:ALAXIA X SELF CONC/C | -.1108E 01 | .1131E 01 | .9604E 00 | -.4495E 00 | L×Q3 |
| 11 | CRP:ALAXIA X A-TRAIT | -.1544E 01 | .9116E 00 | .2869E 01 | -.7008E 00 | L×A-T |
| 12 | CRP:GROUP ADH. X SELF CONC/C | -.2651E 01 | .1285E 01 | .4261E 01 | -.1016E 01 | Q2×Q3 |
| 13 | CRP:GROUP ADH. X A-TRAIT | -.1994E 01 | .1235E 01 | .2606E 01 | -.8598E 00 | Q2×A-T |
| 14 | CRP:SELF CONC/C X A-TRAIT | -.2185E 01 | .1136E 01 | .3700E 01 | -.8984E 00 | Q3×A-T |



APP. D.5.
RESULTS OF MQRA IV
SURVEY ANALYSIS

NSTEP NUMBER 2 ENTER VARIABLE 12 CRP:GROUP ADH. X SELF CONC/C
STANDARD ERROR OF ESTIMATE= 22.344
MULTIPLE CORRELATION COEFFICIENT = 0.806
GOODNESS OF FIT: 64.95562%
CONSTANT TERM= 198.9462

| | VARIABLE | COEFF | STD DEV COEFF | F-RATIO VAR.CONTR | BETA COEFF | VAR DESCR.: |
|---|---|---|---|---|---|---|
| 11 | CRP:ALAXIA X A-TRAIT | -.1340E 01 | .2025E 00 | .4380E 02 | -.6082E 00 | LxA-T |
| 12 | CRP:GROUP ADH. X SELF CONC/C | .8928E 00 | .2399E 00 | .1385E 02 | .3420E 00 | Q2xQ3 |

APP. D.5./2
RESULTS OF MQRA IV
FINAL RUN

# APPENDIX E

E.1. FORTRAN - program used for MLRA's

E.2. FORTRAN - program used for MQRA's

E.3. FORTRAN - program used for RSA's

APP. E.1.
FORTRAN PROGRAM USED FOR THE MLRA's

```
BURROUGHS B-5700  FORTRAN  COMPILATION   (MARK XVI.0.05).       FRIDAY, 19/11/76,   17146 H.   UNIVERSITY OF NATAL

                                        MLINEAR/PSPHANS
                                        ===============

 $ SET TAPE LISTP                                                                R  0000
FILE  2 =  INPUT              ,UNIT = READER                           00000000 T  0000
FILE  3 =  OUTPUT             ,UNIT = PRINTER                          00001000 T  0000
FILE  1=LINEAR/REGRESS, UNIT=DISK,  RANDOM, AREA=1001, RECORD=30       00002000 T  0000
C                                                                      00003000 T  0000
C      -------------------------------------------                     00004000 T  0000
C      MULTIPLE LINEAR REGRESSION - INPUT PHASE                        00005000 T  0000
C      -------------------------------------------                     00006000 T  0000
                                                          START OF SEGMENT **********  1
      COMMON I1, R1(30,30), R2(30), R3(30), R4                         00007000 T  0000
      COMMON  NPLOT                                                    00007100 R  0000   PATCH
      DIMENSION  X(30), NAME(10)                                       00008000 T  0000
C                                                                      00009000 T  0000
C==== READ "NUMBER OF OBSERVATIONS", "NUMBER OF VARIABLES", AND        00010000 T  0000
C          "NAME OF PROJECT".                                          00011000 T  0000
      READ (2,100) NOBS, NVAR, NAME                                    00012000 T  0000
 100  FORMAT ( 2I4, 2X, 10A6 )                                         00013000 T  0015
      WRITE(3,953)                                                     00014000 R  0015   PATCH
      WRITE (3,958)                                                             R  0018   PATCH
      WRITE(3,954)                                                              R  0022   PATCH
954   FORMAT (3X,"OBS.NO.","PF/A"1X,"PF/B",1X,"PF/C",1X,"PF/E",1X,"PF/F"        R  0025   PATCH
     ",1X,"PF/G",1X,"PF/H",1X,"PF/I",1X,"PF/L",1X,"PF/M",1X,"PF/N",1X,"PF/       R  0026   PATCH
     -F/O",1X,"P/Q1",1X,"PFQ2",1X,"P/Q3",1X,"P/Q4",1X,"STATE","TRAIT",1X        R  0026   PATCH
     -,"INT.",1X,"AGE",2X,"EXP.",1X,"SCORE")                                    R  0026   PATCH
958    FORMAT (10X,"ORIGINAL DATA MATRIX",/)                                    R  0026   PATCH
953   FORMAT(10X,"PERSONALITY CORRELATES TO PERFORMANCE UNDER STRESS",10        R  0026   PATCH
     -X,"H.P.LEHMANN",//)                                                       R  0026   PATCH
      DO 20 J=1, NOBS                                                  00015000 T  0026
C==== READ THE DEPENDANT AND INDEPENDANT VARIABLES (DEPENDANT LAST)    00016000 T  0026
      READ (2,200) ( X(K), K=1,NVAR)                                   00017000 T  0031
C---- THE FOLLOWING FORMAT MAY BE CHANGED TO SUIT YOUR REQUIREMENTS    00018000 T  0045
C                                                                      00019000 T  0045
200   FORMAT (22F3.0)                                                  00020000 R  0049   PATCH
C                                                                      00021000 T  0049
C---- DO 10 K=1, NVAR           PERFORM ANY TRANSFORMATIONS OF DATA HERE.  00022000 T  0049
C---- X(K) = ALOG( X(K) )       E.G. A NAPERIAN LOGARITHM AS SHOWN,    00023000 T  0049
C---- X(K) = X(K)*X(K)          OR SQUARE, ETC, OR NONE.               00024000 T  0049
      WRITE (3,955) J,(X(K),K=1,NVAR)                                  00025000 R  0049   PATCH
955   FORMAT(I10, 22F5.0)                                                       R  0068   PATCH
  20  WRITE (1"J)  X                                                   00026000 T  0068
C---- NOW CALL THE SUBROUTINE THAT DOES ALL THE LINEAR REGRESSING      00027000 T  0069
      CALL REGR1                                                       00028000 T  0079
C==== READ THE "F VALUES" FOR VARIABLES (1) TO ENTER, & (2) TO LEAVE   00029000 T  0079
C     THE REGRESSION EQUATION, AND AN OPTION TO PRINT THE RESIDUALS.   00030000 T  0079
      READ (2,300,END=50)FIN,FOUT,IRES,NPLOT                           00031000 R  0079   PATCH
300   FORMAT(2F10.5,2I2)                                               00032000 R  0097   PATCH
      CALL REGR2 ( FIN, FOUT, IRES )                                   00033000 T  0098
      STOP                                                             00034000 T  0099
  50  CALL REGR2 ( 0.0, 0.0, 1 )                                       00035000 T  0101
      STOP                                                             00036000 T  0102
      END                                                              00037000 T  0104
C                                                                      00038000 T  0104
C                                                                      00039000 T  0104
                                                                  SEGMENT    1 IS  115 LONG
```

```
                                                   START OF SEGMENT **********   2
      SUBROUTINE REGR1                                       T  0000
C---  MULTIPLE LINEAR REGRESSION - PHASE 1                   T  0000
      COMMON NVAR, R(30,30), XBAR(30), SIGMA(30), OBS        T  0000
      DIMENSION  X(30), NAME(10)                             T  0000
C                                                            T  0000
      READ (1"0) NOBS, NVAR, NAME                            T  0000
      OBS=NOBS                                               T  0017
      DO 2 J=1,NVAR                                          T  0018
      XBAR(J)=0.                                             T  0024
      DO 2 K=1,NVAR                                          T  0026
    2 R(J,K)=0.                                              T  0033
      DO 3 I=1,NOBS                                          T  0036
      READ (1"I)  X                                          T  0042
      DO 4 J=1,NVAR                                          T  0055
      XBAR(J)=XBAR(J)+X(J)                                   T  0061
      DO 4 K=1,J                                             T  0065
      R(J,K)=R(J,K)+X(J)*X(K)                                T  0070
    4 R(K,J)=R(J,K)                                          T  0078
    3 CONTINUE                                               T  0084
      DO 5 J=1,NVAR                                          T  0084
    5 SIGMA(J)=SQRT(R(J,J)-XBAR(J)*XBAR(J)/OBS)              T  0091
      DO 6 J=1,NVAR                                          T  0098
      DO 6 K=1,J                                             T  0105
      R(J,K)=(R(J,K)-XBAR(J)*XBAR(K)/OBS)/(SIGMA(J)*SIGMA(K))  T  0111
    6 R(K,J)=R(J,K)                                          T  0122
      DEN=SQRT(OBS-1.)                                       T  0127
      DO 7 J=1,NVAR                                          T  0129
      XBAR(J)=XBAR(J)/OBS                                    T  0135
    7 SIGMA(J)=SIGMA(J)/DEN                                  T  0139
      WRITE(3,200)NAME                                       T  0142
  200 FORMAT ( 11X, 10A6 // )                                T  0156
      WRITE(3,201)                                           T  0156
  201 FORMAT(1H0" VAR        MEAN   STD DEV"/)               T  0160
      WRITE(3,202)(J,XBAR(J),SIGMA(J),J=1,NVAR)              T  0160
  202 FORMAT(1X,I4,2F10.2)                                   T  0183
      WRITE(3,203)                                           T  0183
  203 FORMAT(1H0,10X,"SIMPLE CORRELATION CO-EFFICIENTS")     T  0187
      DO 10 J=1,NVAR                                         T  0187
   10 WRITE(3,204)(J,K,R(J,K),K=1,NVAR)                      T  0194
  204 FORMAT(6(2I4,F8.4,4X))                                 T  0217
C     CALL LINK(REGR2)                                       T  0217
      RETURN                                                 T  0217
      END                                                    T  0220
C                                                            T  0220
C                                                            T  0220
C                                                            T  0220
C                                                            T  0220
C                                                            T  0220
C                                                            T  0220
C                                                            T  0220
                                                   SEGMENT    2 IS  230 LONG
```

```
                                                      START OF SEGMENT **********    3
      SUBROUTINE REGR2 ( FIN, FOUT, IRES )                        00090000 T  0000
C***  MULTIPLE LINEAR REGRESSION - PHASE 2                         00091000 T  0000
      COMMON  NVAR, RIJ(30,30), XBAR(30), SIGMA(30), OBS            00092000 T  0000
      COMMON   NPLOT                                                00092100 R  0000   PATCH
      DIMENSION SIGB(30), B(30), ID(30), DATA(30)                   00093000 T  0000
      DIMENSION RPLOT(1000)                                         00093100 R  0000   PATCH
C                                                                   00094000 T  0000
      NINDV=NVAR-1                                                  00095000 T  0000
      NOBS=OBS                                                      00096000 T  0001
C     PHASE 2. PERFORM STEPWISE CALCULATIONS AND PRINT RESULTS.     00097000 T  0001
C     DIMENSIONS                                                    00098000 T  0001
C     INITIALIZE                                                    00099000 T  0001
      DO 190 I=1,NVAR                                               00100000 T  0003
      SIGB(I)=0.0                                                   00101000 T  0009
  190 B(I)=0.0                                                      00102000 T  0012
      NENT=0                                                        00103000 T  0014
      DF=OBS-1.0                                                    00104000 T  0015
      NSTEP=-1                                                      00105000 T  0018
C     TRANSFORM SIGMA VECTOR FROM STANDARD DEVIATIONS TO SQUARE     00106000 T  0018
C     ROOTS OF SUMS OF SQUARES.                                     00107000 T  0018
      DO 310 I=1,NVAR                                               00108000 T  0019
  310 SIGMA(I)=SIGMA(I)*SQRT(OBS-1.0)                               00109000 T  0027
C                                                                   00110000 T  0032
C     BEGIN STEP NUMBER NSTEP.                                      00111000 T  0032
  200 NSTEP=NSTEP+1                                                 00112000 T  0034
      WRITE (3,3000)                                                00112100 R  0035   PATCH
 3000 FORMAT("1")                                                            R  0038   PATCH
      STDEE=SQRT(RIJ(NVAR,NVAR)/DF) * SIGMA(NVAR)                   00113000 T  0039
      DF=DF-1.0                                                     00114000 T  0044
      IF(DF)1010,1010,205                                           00115000 T  0047
  205 VMIN=0.0                                                      00116000 T  0050
      VMAX=0.0                                                      00117000 T  0050
      NIN=0                                                         00118000 T  0051
C     FIND MINIMUM VARIANCE CONTRIBUTION OF VARIABLES IN REGRESSION 00119000 T  0051
C     EQUATION. FIND MAXIMUM VARIANCE CONTRIBUTION OF VARIABLES     00120000 T  0051
C     NOT IN REGRESSION EQUATION.                                   00121000 T  0051
      DO 300 I=1,NINDV                                              00122000 T  0052
      IF(RIJ(I,I)-.001)300,300,210                                  00123000 T  0057
  210 VI=RIJ(I,NVAR)*RIJ(NVAR,I)/RIJ(I,I)                           00124000 T  0065
      IF(VI)240,300,220                                             00125000 T  0072
  220 IF(VI-VMAX)300,300,230                                        00126000 T  0078
  230 VMAX=VI                                                       00127000 T  0081
      NMAX=I                                                        00128000 T  0081
      GO TO 300                                                     00129000 T  0082
  240 NIN=NIN+1                                                     00130000 T  0084
      ID(NIN)=I                                                     00131000 T  0085
C     COMPUTE REGRESSION COEFFICIENT AND ITS STANDARD DEVIATION.    00132000 T  0086
      B(NIN)=RIJ(I,NVAR)*SIGMA(NVAR)/SIGMA(I)                       00133000 T  0087
      SIGB(NIN)=STDEE*SQRT(RIJ(I,I))/SIGMA(I)                       00134000 T  0093
      IF(VMIN)250,260,1000                                          00135000 T  0099
  250 IF(VI-VMIN)300,300,260                                        00136000 T  0104
  260 VMIN=VI                                                       00137000 T  0107
      NMIN=I                                                        00138000 T  0107
  300 CONTINUE                                                      00139000 T  0109
      IF(NIN)1000,460,400                                           00140000 T  0109
C     COMPUTE CONSTANT TERM.                                        00141000 T  0109
  400 BSUBO=XBAR(NVAR)                                              00142000 T  0115
      DO 410 I=1,NIN                                                00143000 T  0116
      J=ID(I)                                                       00144000 T  0122
  410 BSUBO=BSUBO-B(I)*XBAR(J)                                      00145000 T  0125
      IF(NENT)1000,480,420                                          00146000 T  0128
C     OUTPUT FOR VARIABLE ADDED                                     00147000 T  0129
```

142.

E.1./3

```
  420 WRITE(3,57)NSTEP,K                                              00148000 T  0134
   57 FORMAT("OSTEP NUMBER ",I2,10X,"ENTER VARIABLE ",I2)             00149000 T  0146
  425 WRITE(3,58)STDEE                                                00150000 T  0146
   58 FORMAT(" STANDARD ERROR OF ESTIMATE=",F11.3)                    00151000 T  0156
                                                                     SEGMENT    4 IS  126 LONG
      R=SQRT(1.0-RIJ(NVAR,NVAR))                                      00152000 T  0156
      WRITE(3,59)R                                                    00153000 T  0161
   59 FORMAT(" MULTIPLE CORRELATION COEFFICIENT =",F6.3)              00154000 T  0172
      IDFN=OBS-DF-2.0                                                 00155000 T  0172
      IDFD=DF+1.0                                                     00156000 T  0176
C-------------------------------------------------------------------- 00157000 R  0176  PATCH
C     EXPRESS GOODNESS OF FIT AS PERCENTAGE-FIT, GIVING THE RATIO OF           R  0176  PATCH
C     SUMS OF SQUARES DUE TO REGRESSION VERSUS THE TOTAL SUM OF SQUARES        R  0176  PATCH
C-------------------------------------------------------------------- 00158000 R  0176  PATCH
      FIT= (R**2)*100                                                          R  0180  PATCH
      WRITE (3,66) FIT                                                00159000 R  0182  PATCH
66    FORMAT (1X,"GOODNESS OF FIT:",F8.4,"%")                         00160000 R  0191  PATCH
      WRITE(3,60)BSUBO                                                00161000 T  0192
   60 FORMAT(" CONSTANT TERM=",F12.4)                                 00162000 T  0202
      WRITE(3,61)                                                     00163000 T  0202
61    FORMAT (3X,"VAR",5X,"COEFF",5X,"STD DEV",4X,"F-RATIO",1X,"BETA COE00164000 R  0205  PATCH
     -FF")                                                                     R  0206  PATCH
      WRITE(3,62)                                                     00165000 T  0206
62    FORMAT (23X,"COEFF",2X,"VAR.CONTR")                             00166000 R  0209  PATCH
      DO 430 I=1,NIN                                                  00167000 T  0210
      J=ID(I)                                                         00168000 T  0215
      T=B(I)/SIGB(I)                                                  00169000 T  0217
C-------------------------------------------------------------------- 00169050 R  0218  PATCH
C     INSTEAD OF USING THE RAW T-VALUE USE T T-SQU. AS F-RATIO FOR THE 00169100 R  0218  PATCH
C     SIGNIFICANCE OF THE CONTRIBUTION OF VARIABLES TO THE OVERALL FIT         R  0218  PATCH
C--------------------------------------------------------------------          R  0218  PATCH
      T=T**2                                                                   R  0220  PATCH
  430 WRITE(3,63)ID(I),B(I),SIGB(I),T,RIJ(J,NVAR)                     00170000 T  0222
63    FORMAT (3X,I3,4E11.4)                                           00171000 R  0245  PATCH
C     COMPUTE F LEVEL FOR MINIMUM VARIANCE CONTRIBUTION VARIABLE      00172000 T  0245
C     IN REGRESSION EQUATION.                                         00173000 T  0245
      FLEVL=VMIN*DF/RIJ(NVAR,NVAR)                                    00174000 T  0245
      IF(FOUT+FLEVL)460,460,450                                       00175000 T  0249
C     INITIALIZE FOR REMOVAL OF VARIABLE K FROM EQUATION.             00176000 T  0249
  450 K=NMIN                                                          00177000 T  0252
      NENT=0                                                          00178000 T  0252
      DF=DF+2.0                                                       00179000 T  0253
      GO TO 500                                                       00180000 T  0256
C     COMPUTE F LEVEL FOR MAXIMUM VARIANCE CONTRIBUTION VARIABLE      00181000 T  0256
C     NOT IN EQUATION.                                                00182000 T  0256
  460 FLEVL=VMAX*DF/(RIJ(NVAR,NVAR)-VMAX)                             00183000 T  0258
      IF(FLEVL-FIN)600,600,470                                        00184000 T  0262
C     INITIALIZE FOR ENTRY OF VARIABLE K INTO EQUATION.               00185000 T  0263
  470 K=NMAX                                                          00186000 T  0266
      NENT=K                                                          00187000 T  0266
      GO TO 500                                                       00188000 T  0267
C     OUTPUT FOR VARIABLE DELETED                                     00189000 T  0267
  480 WRITE(3,64)NSTEP,K                                              00190000 T  0269
   64 FORMAT("OSTEP NUMBER ",I2,10X,"DELETE VARIABLE ",I2)            00191000 T  0281
      GO TO 425                                                       00192000 T  0281
C                                                                     00193000 T  0281
C     UPDATE MATRIX                                                   00194000 T  0281
  500 STDEE=1.0/RIJ(K,K)                                              00195000 T  0282
      DO 540 I=1,NVAR                                                 00196000 T  0286
      IF(I-K)510,540,510                                              00197000 T  0293
  510 DO 530 J=1,NVAR                                                 00198000 T  0297
      IF(J-K)520,530,520                                              00199000 T  0303
  520 RIJ(I,J)=RIJ(I,J)-RIJ(I,K)*RIJ(K,J)*STDEE                       00200000 T  0307
```

```
  530 CONTINUE                                                   00201000 T  0317
  540 CONTINUE                                                   00202000 T  0318
      DO 560 J=1,NVAR                                            00203000 T  0318
      IF(J-K)550,560,550                                         00204000 T  0324
  550 RIJ(K,J)=RIJ(K,J)*STDEE                                    00205000 T  0328
  560 CONTINUE                                                   00206000 T  0333
      DO 580 I=1,NVAR                                            00207000 T  0333
      IF(I-K)570,580,570                                         00208000 T  0339
  570 RIJ(I,K)=-RIJ(I,K)*STDEE                                   00209000 T  0343
  580 CONTINUE                                                   00210000 T  0349
      RIJ(K,K)=STDEE                                             00211000 T  0349
      GO TO 200                                                  00212000 T  0352
C                                                                00213000 T  0352
  600 IF(IRES)610,640,610                                        00214000 T  0353
C     PRINT RESIDUALS                                            00215000 T  0353
  610 IFA=2                                                      00216000 T  0356
      WRITE(3,67)                                                00217000 T  0356
   67 FORMAT("0 OBS        ACTUAL     ESTIMATE     RESIDUAL")      00218000 T  0361
      DO 630 K=1,NOBS                                            00219000 T  0361
      READ (1"K) (DATA(I), I=1,NVAR)                             00220000 T  0366
      EST=BSUBO                                                  00221000 T  0384
      DO 620 I=1,NIN                                             00222000 T  0385
      J=ID(I)                                                    00223000 T  0390
  620 EST=EST+B(I)*DATA(J)                                       00224000 T  0393
      RESID=DATA(NVAR)-EST                                       00225000 T  0396
      RPLOT (K)=RESID                                            00225100 R  0399   PATCH
      WRITE(3,68)K,DATA(NVAR),EST,RESID                          00226000 T  0400
   68 FORMAT(" ",I4,3F12.2)                                      00227000 T  0418
  630 CONTINUE                                                   00228000 T  0418
      IF (NPLOT.EQ.1) CALL PLOT(RPLOT,NVAR,NOBS)                 00228100 R  0418   PATCH
C---   NORMAL END OF PROGRAM                                     00229000 T  0422
  640 STOP                                                       00230000 T  0423
 1000 CALL ERROR(1)                                              00231000 T  0425
 1010 CALL ERROR(2)                                              00232000 T  0426
 1020 CALL ERROR(3)                                              00233000 T  0427
         END                                                     00234000 T  0427
                                                                SEGMENT    3 IS  453 LONG

----------------------------------------------------------------------------------------------------

                                                         START OF SEGMENT **********    5
      SUBROUTINE ERROR( I )                                      00235000 T  0000
      GO TO (10, 20, 30), I                                      00236000 T  0000
   10 WRITE (3,100)                                              00237000 T  0007
  100 FORMAT ("0ERROR... NIN, NENT, VMIN, NCONS, OR NTRAN IS NEGATIVE. 00238000 T  0011
     *CHECK FOR ERROR ON PARAMETER CARDS" )                      00239000 T  0011
      STOP                                                       00240000 T  0011
   20 WRITE (3,200)                                              00241000 T  0013
  200 FORMAT ("0ERROR... DEGREES OF FREEDOM = 0.  EITHER ADD MORE OBSERV00242000 T  0017
     *ATIONS OR DELETE ONE OR MORE INDEPENDANT VARIABLE." / " SAMPLE SIZ00243000 T  0017
     *E MUST EXCEED NUMBER OF INDEPENDANT VARIABLES BY AT LEAST 2." )  00244000 T  0017
      STOP                                                       00245000 T  0017
   30 WRITE (3,300)                                              00246000 T  0019
  300 FORMAT ("0ERROR... F LEVEL FOR INCOMING VARIABLE IS LESS THAN F LE00247000 T  0023
     *VEL FOR OUTGOING VARIABLE." )                              00248000 T  0023
                                                                SEGMENT    6 IS  119 LONG
      STOP                                                       00249000 T  0023
      END                                                        00250000 T  0024
```

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-----------------------------------------------------------------------------------------------------------------------------

      SUBROUTINE  PLOT(Y,NVAR,NOBS)                                    00300000 R  0029   PATCH
                                                              START OF SEGMENT **********    7
      DIMENSION Y(NOBS),X(1000),DUMMY(30),GRAPH(50,100)                         R  0000   PATCH
      NX=80                                                                     R  0000   PATCH
      NY=20                                                                     R  0000   PATCH
C-----CALCULATE THE MAXIMUM AND MINIMUM OF ORDINATE Y                           R  0000   PATCH
      CALL MAXMIN(Y,NOBS,YMAX,YMIN)                                             R  0001   PATCH
      YFACT=(YMAX-YMIN)/(NY-1)                                                  R  0003   PATCH
C-----ONE LOOP FOR EACH GRAPH                                                   R  0005   PATCH
      DO 500 J=1,NVAR                                                           R  0006   PATCH
      WRITE(3,3000)                                                             R  0011   PATCH
3000  FORMAT("1")                                                               R  0015   PATCH
C-----READ IN VARIABLE J                                                        R  0016   PATCH
      DO 50 I=1,NOBS                                                            R  0016   PATCH
      READ (1"I)(DUMMY(L),L=1,NVAR)                                             R  0021   PATCH
      X(I)=DUMMY(J)                                                             R  0039   PATCH
50    CONTINUE                                                                  R  0041   PATCH
C-----NOW FIND THE MAIMUM AND MINIMUM OF X                                      R  0042   PATCH
      CALL MAXMIN(X,NOBS,XMAX,XMIN)                                             R  0042   PATCH
      XFACT=(XMAX-XMIN)/(NX-1)                                                  R  0044   PATCH
C---- INITIALISE GRAPH                                                          R  0046   PATCH
      DO 40 I=1,NX+1                                                            R  0047   PATCH
         DO 40 K=1,NY+1                                                         R  0053   PATCH
40    GRAPH (K,I)=0                                                             R  0060   PATCH
C---- PLOT POINTS                                                               R  0065   PATCH
      DO 100 I=1,NOBS                                                           R  0067   PATCH
      NXPOS=IFIX((X(I)-XMIN)/XFACT+0.5)+1                                       R  0072   PATCH
      NYPOS=IFIX((Y(I)-YMIN)/YFACT+0.5)+1                                       R  0078   PATCH
      GRAPH(NYPOS,NXPOS)=GRAPH(NYPOS,NXPOS)+1                                   R  0084   PATCH
100   CONTINUE                                                                  R  0094   PATCH
C---- PUT IN X AND Y AXES                                                       R  0095   PATCH
      DO 60 I=1,NY                                                              R  0095   PATCH
         GRAPH(I,1)=13                                                          R  0100   PATCH
60    CONTINUE                                                                  R  0105   PATCH
      DO 70 I=1,NX                                                              R  0105   PATCH
         GRAPH(1,I)=44                                                          R  0110   PATCH
70    CONTINUE                                                                  R  0115   PATCH
C---- NOW PRINT THE GRAPH                                                       R  0116   PATCH
      DO 120 II=1,NY+1                                                          R  0116   PATCH
         DO 120 JJ = 1,NX+1                                                     R  0122   PATCH
            IF(GRAPH(II,JJ).EQ.0)GRAPH(II,JJ)=48                                R  0129   PATCH
120   CONTINUE                                                                  R  0140   PATCH
      DO 200 I=1,NY+1                                                           R  0142   PATCH
         II=NY-I+2                                                              R  0148   PATCH
         WRITE(3,1000)(GRAPH(II,K),K=1,NX+1)                                    R  0150   PATCH
1000  FORMAT(1X,130C1)                                                          R  0172   PATCH
200   CONTINUE                                                                  R  0173   PATCH
C---- PRINT OUT GRAPH DATA                                                      R  0173   PATCH
      WRITE(3,2000)J,XMIN,XMAX,XFACT,YMIN,YMAX,YFACT,NOBS                       R  0173   PATCH
2000  FORMAT(" GRAPH OF VARIABLE",I4," VS. RESIDUALS "//                        R  0197   PATCH
     -" X-AXIS BOUNDS ARE:",F12.6,3X,F12.6,"      X INCREMENT =",F12.6/         R  0198   PATCH
     -" Y-AXIS BOUNDS ARE:",F12.6,3X,F12.6,"      Y INCREMENT =",F12.6/         R  0198   PATCH
     -" NO. OF OBSERVATIONS = ",I4)                                             R  0198   PATCH
500   CONTINUE                                                                  R  0198   PATCH
      RETURN                                                                    R  0198   PATCH
```

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      END                                                   R  0201   PATCH
                                                   SEGMENT    7 IS  221 LONG
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      SUBROUTINE MAXMIN (A,N,RMAX,RMIN)            00500000 R  0220   PATCH
                                          START OF SEGMENT **********    8
      DIMENSION A(N)                                        R  0000   PATCH
      RMAX=-1E40                                            R  0000   PATCH
      RMIN=1E40                                             R  0002   PATCH
      DO 100 J=1,N                                          R  0005   PATCH
      IF(A(J).GT.RMAX)RMAX=A(J)                             R  0010   PATCH
      IF(A(J).LT.RMIN)RMIN=A(J)                             R  0015   PATCH
100   CONTINUE                                              R  0020   PATCH
      RMAX = IFIX(RMAX+1)                                   R  0021   PATCH
      RMIN = IFIX(RMIN-1)                                   R  0023   PATCH
      RETURN                                                R  0025   PATCH
      END                                                   R  0028   PATCH
                                                   SEGMENT    8 IS   39 LONG
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                                                   99999999 R  0038   PATCH
                                                   SEGMENT    9 IS   53 LONG
                                                   SEGMENT   10 IS   29 LONG
                                                   SEGMENT   11 IS  138 LONG
                                          START OF SEGMENT **********   12
                                                   SEGMENT   12 IS   16 LONG

NUMBER OF CARDS = 345                 CORE MEMORY ALLOCATION = 8064 WORDS.

COMPILATION TIME = 17 SECS;           ELAPSED TIME = 55 SECS
```

MLINEAR/PSPHANS

```
$ SET TAPE LISTP                                                            R  0000
FILE  2 =  INPUT              ,UNIT = READER                       00000000 T  0000
FILE  3 =  OUTPUT             ,UNIT = PRINTER                      00001000 T  0000
FILE  1=LINEAR/REGRESS, UNIT=DISK,  RANDOM, AREA=1001, RECORD=30   00002000 T  0000
C                                                                  00003000 T  0000
C     ------------------------------------------                   00004000 T  0000
C     MULTIPLE LINEAR REGRESSION - INPUT PHASE                     00005000 T  0000
C     ------------------------------------------                   00006000 T  0000
                                                        START OF SEGMENT **********  1
      COMMON I1, R1(30,30), R2(30), R3(30), R4                     00007000 T  0000
      COMMON  NPLOT                                                00007100 R  0000   PATCH
      DIMENSION X(90,30),NAME(10)   , SQUVN(10)                    00008000 R  0000   PATCH
      READ (2,100) NOBS, NVAR, NSQU                                00009000 R  0000   PATCH
100   FORMAT (3I5)                                                 00010000 R  0013   PATCH
      READ (2,150) NAME                                            00011000 R  0014   PATCH
150   FORMAT (10A6)                                                00012000 R  0024   PATCH
      READ (2,200)   (SQUVN(I),I=1,NSQU)                           00013000 R  0025   PATCH
200   FORMAT (6I3)                                                 00013100 R  0042   PATCH
      WRITE(3,953)                                                          R  0042   PATCH
953   FORMAT(10X,"PERSONALITY CORRELATES TO PERFORMANCE UNDER STRESS",10    R  0045   PATCH
     -X,"H.P.LEHMANN",//)                                                   R  0046   PATCH
      WRITE (3,958)                                                         R  0046   PATCH
958    FORMAT (10X,"ORIGINAL DATA MATRIX",/)                                R  0049   PATCH
      WRITE(3,954)                                                          R  0050   PATCH
954   FORMAT (3X,"OBS.NO.","PF/A"1X,"PF/B",1X,"PF/C",1X,"PF/E",1X,"PF/F"    R  0053   PATCH
     -",1X,"PF/G",1X,"PF/H",1X,"PF/I",1X,"PF/L",1X,"PF/M",1X,"PF/N",1X,"PF/ R  0054   PATCH
     -F/O",1X,"P/Q1",1X,"PFQ2",1X,"P/Q3",1X,"P/Q4",1X,"STATE","TRAIT",1X    R  0054   PATCH
     -,"INT.",1X,"AGE",2X,"EXP.",1X,"SCOPE")                                R  0054   PATCH
      DO 10 K=1,NOBS                                               00014000 R  0054   PATCH
        READ (2,250) (X(K,J),J=1,NVAR)                             00015000 R  0059   PATCH
250     FORMAT (19F3.0,6X,1F3.0)                                   00016000 R  0081   PATCH
      WRITE (3,955) K,(X(K,J),J=1,NVAR)                                     R  0081   PATCH
955   FORMAT (I10,19F5.0,10X,1F5.0)                                         R  0104   PATCH
        DEPVAR = X(K,NVAR)                                         00017000 R  0104   PATCH
        I=1                                                        00018000 R  0109   PATCH
        DO 20 J = 1, NVAR                                          00019000 R  0109   PATCH
             IF ( J.NE.SQUVN(I)) GO TO 20                          00020000 R  0115   PATCH
                X(K,I) = X(K,J)                                    00021000 R  0118   PATCH
             X(K,I+NSQU) = X(K,J) **2                              00022000 R  0128   PATCH
             I=I+1                                                          R  0138   PATCH
20      CONTINUE                                                   00023000 R  0140   PATCH
        J = 2*NSQU                                                 00024000 R  0140   PATCH
          DO 30 M=1,NSQU -1                                        00025000 R  0141   PATCH
            DO 40 N = M+1,NSQU                                     00026000 R  0148   PATCH
               J = J + 1                                                    R  0150   PATCH
               X (K,J) = X(K,M) * X(K,N)                                    R  0156   PATCH
40           CONTINUE                                                       R  0170   PATCH
30           CONTINUE                                                       R  0171   PATCH
        X(K,J+1) = DEPVAR                                                   R  0172   PATCH
10    CONTINUE                                                              R  0178   PATCH
      NVAR = J + 1                                                          R  0179   PATCH
      WRITE (1"0) NOBS,NVAR,NAME                                            R  0180   PATCH
      DO 45 J = 1,NOBS                                                      R  0195   PATCH
45    WRITE (1"J) (X(J,I),I=1,NVAR)                                         R  0200   PATCH
C---- NOW CALL THE SUBROUTINE THAT DOES ALL THE LINEAR REGRESSING   00027000 T  0218
      CALL REGR1                                                   00028000 T  0222
C==== READ THE "F VALUES" FOR VARIABLES (1) TO ENTER, & (2) TO LEAVE 00029000 T 0222
```

147.

APP. E.2.
FORTRAN PROGRAM
USED FOR THE MLRA'S

```
C     THE REGRESSION EQUATION, AND AN OPTION TO PRINT THE RESIDUALS.     00030000 T  0222
      READ (2,300,END=50)FIN,FOUT,IRES,NPLOT                             00031000 R  0223   PATCH
300   FORMAT(2F10.5,2I2)                                                 00032000 R  0240   PATCH
      CALL REGR2 ( FIN, FOUT, IRES )                                     00033000 T  0241
      STOP                                                               00034000 T  0242
  50  CALL REGR2 ( 0.0, 0.0, 1 )                                         00035000 T  0244
      STOP                                                               00036000 T  0245
      END                                                                00037000 T  0247
C                                                                        00038000 T  0247
C                                                                        00039000 T  0247
                                                                         SEGMENT    1 IS  261 LONG
```

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```
                                                                START OF SEGMENT **********   2
      SUBROUTINE REGR1                                                   00040000 T  0000
C---  MULTIPLE LINEAR REGRESSION - PHASE 1                               00041000 T  0000
      COMMON NVAR, R(30,30), XBAR(30), SIGMA(30), OBS                    00042000 T  0000
      DIMENSION  X(30), NAME(10)                                         00043000 T  0000
C                                                                        00044000 T  0000
      READ (1"0) NOBS, NVAR, NAME                                        00045000 T  0000
      OBS=NOBS                                                           00046000 T  0017
      DO 2 J=1,NVAR                                                      00047000 T  0018
      XBAR(J)=0.                                                         00048000 T  0024
      DO 2 K=1,NVAR                                                      00049000 T  0026
    2 R(J,K)=0.                                                          00050000 T  0033
      DO 3 I=1,NOBS                                                      00051000 T  0036
      READ (1"1)  X                                                      00052000 T  0042
      DO 4 J=1,NVAR                                                      00053000 T  0055
      XBAR(J)=XBAR(J)+X(J)                                               00054000 T  0061
      DO 4 K=1,J                                                         00055000 T  0065
      R(J,K)=R(J,K)+X(J)*X(K)                                            00056000 T  0070
    4 R(K,J)=R(J,K)                                                      00057000 T  0078
    3 CONTINUE                                                           00058000 T  0084
      DO 5 J=1,NVAR                                                      00059000 T  0084
    5 SIGMA(J)=SQRT(R(J,J)-XBAR(J)*XBAR(J)/OBS)                          00060000 T  0091
      DO 6 J=1,NVAR                                                      00061000 T  0098
      DO 6 K=1,J                                                         00062000 T  0105
      R(J,K)=(R(J,K)-XBAR(J)*XBAR(K)/OBS)/(SIGMA(J)*SIGMA(K))            00063000 T  0111
    6 R(K,J)=R(J,K)                                                      00064000 T  0122
      DEN=SQRT(OBS-1.)                                                   00065000 T  0127
      DO 7 J=1,NVAR                                                      00066000 T  0129
      XBAR(J)=XBAR(J)/OBS                                                00067000 T  0135
    7 SIGMA(J)=SIGMA(J)/DEN                                              00068000 T  0139
      WRITE (3,3000)                                                     00068100 R  0142   PATCH
3000  FORMAT ("1")                                                                R  0146   PATCH
      WRITE  (3,3001)                                                             R  0146   PATCH
3001  FORMAT ( 10X," MULTIPLE QUADRATIC REGRESSION")                              R  0149   PATCH
      WRITE (3,3002)                                                              R  0150   PATCH
3002  FORMAT (10X,"------------------------------")                               R  0153   PATCH
      WRITE(3,200)NAME                                                   00069000 T  0154
  200 FORMAT ( 11X, 10A6 // )                                            00070000 T  0167
      WRITE(3,201)                                                       00071000 T  0167
  201 FORMAT(1H0" VAR        MEAN    STD DEV"/)                          00072000 T  0171
      WRITE(3,202)(J,XBAR(J),SIGMA(J),J=1,NVAR)                          00073000 T  0171
  202 FORMAT(1X,I4,2F10.2)                                               00074000 T  0194
      WRITE(3,203)                                                       00075000 T  0194
  203 FORMAT(1H0,10X,"SIMPLE CORRELATION CO-EFFICIENTS")                 00076000 T  0198
```

```
      DO 10 J=1,NVAR                                                    SEGMENT    3 IS  126 LONG
   10 WRITE(3,204)(J,K,R(J,K),K=1,NVAR)                                 00077000 T  0198
  204 FORMAT(6(2I4,F8.4,4X))                                            00078000 T  0205
C     CALL LINK(REGR2)                                                  00079000 T  0228
      RETURN                                                            00080000 T  0228
      END                                                               00081000 T  0228
C                                                                       00082000 T  0231
C                                                                       00083000 T  0231
C                                                                       00084000 T  0231
C                                                                       00085000 T  0231
C                                                                       00086000 T  0231
C                                                                       00087000 T  0231
C                                                                       00088000 T  0231
C                                                                       00089000 T  0231
                                                                        SEGMENT    2 IS  241 LONG
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                                                           START OF SEGMENT **********   4
      SUBROUTINE REGR2 ( FIN, FOUT, IRES )                              00090000 T  0000
C---  MULTIPLE LINEAR REGRESSION - PHASE 2                               00091000 T  0000
      COMMON  NVAR, RIJ(30,30), XBAR(30), SIGMA(30), OBS                00092000 T  0000
      COMMON    NPLOT                                                   00092100 R  0000   PATCH
      DIMENSION SIGB(30), B(30), ID(30), DATA(30)                       00093000 T  0000
      DIMENSION RPLOT(1000)                                             00093100 R  0000   PATCH
C                                                                       00094000 T  0000
      NINDV=NVAR-1                                                      00095000 T  0000
      NOBS=OBS                                                          00096000 T  0001
C     PHASE 2. PERFORM STEPWISE CALCULATIONS AND PRINT RESULTS.         00097000 T  0001
C     DIMENSIONS                                                        00098000 T  0001
C     INITIALIZE                                                        00099000 T  0001
      DO 190 I=1,NVAR                                                   00100000 T  0003
      SIGB(I)=0.0                                                       00101000 T  0009
  190 B(I)=0.0                                                          00102000 T  0012
      NENT=0                                                            00103000 T  0014
      DF=OBS-1.0                                                        00104000 T  0015
      NSTEP=-1                                                          00105000 T  0018
C     TRANSFORM SIGMA VECTOR FROM STANDARD DEVIATIONS TO SQUARE         00106000 T  0018
C     ROOTS OF SUMS OF SQUARES.                                         00107000 T  0018
      DO 310 I=1,NVAR                                                   00108000 T  0019
  310 SIGMA(I)=SIGMA(I)*SQRT(OBS-1.0)                                   00109000 T  0027
C                                                                       00110000 T  0032
C     BEGIN STEP NUMBER NSTEP.                                          00111000 T  0032
  200 NSTEP=NSTEP+1                                                     00112000 T  0034
      WRITE (3,3000)                                                    00112100 R  0035   PATCH
 3000 FORMAT("1")                                                                R  0038   PATCH
      STDFE=SQRT(RIJ(NVAR,NVAR)/DF) * SIGMA(NVAR)                       00113000 T  0039
      DF=DF-1.0                                                         00114000 T  0044
      IF(DF)1010,1010,205                                               00115000 T  0047
  205 VMIN=0.0                                                          00116000 T  0050
      VMAX=0.0                                                          00117000 T  0050
      NIN=0                                                             00118000 T  0051
C     FIND MINIMUM VARIANCE CONTRIBUTION OF VARIABLES IN REGRESSION     00119000 T  0051
C     EQUATION. FIND MAXIMUM VARIANCE CONTRIBUTION OF VARIABLES         00120000 T  0051
C     NOT IN REGRESSION EQUATION.                                       00121000 T  0051
      DO 300 I=1,NINDV                                                  00122000 T  0052
      IF(RIJ(I,I)-.001)300,300,210                                      00123000 T  0057
  210 VI=RIJ(I,NVAR)*RIJ(NVAR,I)/RIJ(I,I)                               00124000 T  0065
```

```
      IF(VI)240,300,220                                                00125000 T  0072
  220 IF(VI-VMAX)300,300,230                                           00126000 T  0078
  230 VMAX=VI                                                          00127000 T  0081
      NMAX=I                                                           00128000 T  0081
      GO TO 300                                                        00129000 T  0082
  240 NIN=NIN+1                                                        00130000 T  0084
      ID(NIN)=I                                                        00131000 T  0085
C     COMPUTE REGRESSION COEFFICIENT AND ITS STANDARD DEVIATION.       00132000 T  0086
      B(NIN)=RIJ(I,NVAR)*SIGMA(NVAR)/SIGMA(I)                          00133000 T  0087
      SIGB(NIN)=STDEE*SQRT(RIJ(I,I))/SIGMA(I)                          00134000 T  0093
      IF(VMIN)250,260,1000                                             00135000 T  0099
  250 IF(VI-VMIN)300,300,260                                           00136000 T  0104
  260 VMIN=VI                                                          00137000 T  0107
      NMIN=I                                                           00138000 T  0107
  300 CONTINUE                                                         00139000 T  0109
      IF(NIN)1000,460,400                                              00140000 T  0109
C     COMPUTE CONSTANT TERM.                                           00141000 T  0109
  400 BSUBO=XBAR(NVAR)                                                 00142000 T  0115
      DO 410 I=1,NIN                                                   00143000 T  0116
      J=ID(I)                                                          00144000 T  0122
  410 BSUBO=BSUBO-B(I)*XBAR(J)                                         00145000 T  0125
      IF(NENT)1000,480,420                                             00146000 T  0128
C     OUTPUT FOR VARIABLE ADDED                                        00147000 T  0129
  420 WRITE(3,57)NSTEP,K                                               00148000 T  0134
   57 FORMAT("0STEP NUMBER ",I2,10X,"ENTER VARIABLE ",I2)              00149000 T  0146
  425 WRITE(3,58)STDEE                                                 00150000 T  0146
   58 FORMAT(" STANDARD ERROR OF ESTIMATE=",F11.3)                     00151000 T  0155
      R=SQRT(1.0-RIJ(NVAR,NVAR))                                       00152000 T  0156
      WRITE(3,59)R                                                     00153000 T  0161
   59 FORMAT(" MULTIPLE CORRELATION COEFFICIENT =",F6.3)               00154000 T  0172
      IDFN=OBS-DF-2.0                                                  00155000 T  0172
      IDFD=DF+1.0                                                      00156000 T  0176
C----------------------------------------------------------------------- 00157000 R  0176  PATCH
C     EXPRESS GOODNESS OF FIT AS PERCENTAGE-FIT, GIVING THE RATIO OF             R  0176  PATCH
C     SUMS OF SQUARES DUE TO REGRESSION VERSUS THE TOTAL SUM OF SQUARES          R  0176  PATCH
C----------------------------------------------------------------------- 00158000 R  0176  PATCH
      FIT= (R**2)*100                                                            R  0180  PATCH
      WRITE (3,66) FIT                                                 00159000 R  0182  PATCH
66    FORMAT (1X,"GOODNESS OF FIT:",F8.4,"%")                          00160000 R  0191  PATCH
      WRITE(3,60)BSUBO                                                 00161000 T  0192
   60 FORMAT(" CONSTANT TERM=",F12.4)                                  00162000 T  0202
      WRITE(3,61)                                                      00163000 T  0202
61    FORMAT (3X,"VAR",5X,"COEFF",5X,"STD DEV",4X,"F-RATIO",1X,"BETA COE00164000 R  0205  PATCH
     -FF")                                                                       R  0206  PATCH
      WRITE(3,62)                                                      00165000 T  0206
62    FORMAT (23X,"COEFF",2X,"VAR.CONTR")                              00166000 R  0209  PATCH
      DO 430 I=1,NIN                                                   00167000 T  0210
      J=ID(I)                                                          00168000 T  0215
      T=B(I)/SIGB(I)                                                   00169000 T  0217
C----------------------------------------------------------------------- 00169050 R  0218  PATCH
C     INSTEAD OF USING THE RAW T-VALUE USE T T-SQU. AS F-RATIO FOR THE  00169100 R  0218  PATCH
C     SIGNIFICANCE OF THE CONTRIBUTION OF VARIABLES TO THE OVERALL FIT           R  0218  PATCH
C-----------------------------------------------------------------------          R  0218  PATCH
      T=T**2                                                                     R  0220  PATCH
  430 WRITE(3,63)ID(I),B(I),SIGB(I),T,RIJ(J,NVAR)                      00170000 T  0222
63    FORMAT (3X,I3,4F11.4)                                            00171000 R  0245  PATCH
C     COMPUTE F LEVEL FOR MINIMUM VARIANCE CONTRIBUTION VARIABLE       00172000 T  0245
C.    IN REGRESSION EQUATION.                                          00173000 T  0245
      FLEVL=VMIN*DF/RIJ(NVAR,NVAR)                                     00174000 T  0245
      IF(FOUT+FLEVL)460,460,450                                        00175000 T  0249
C     INITIALIZE FOR REMOVAL OF VARIABLE K FROM EQUATION.              00176000 T  0249
  450 K=NMIN                                                           00177000 T  0252
      NENT=0                                                           00178000 T  0252
```

150.

E.2./4

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      DF=DF+2.0                                                         00179000 T  0253
      GO TO 500                                                         00180000 T  0256
C     COMPUTE F LEVEL FOR MAXIMUM VARIANCE CONTRIBUTION VARIABLE        00181000 T  0256
C     NOT IN EQUATION.                                                  00182000 T  0256
  460 FLEVL=VMAX*DF/(RIJ(NVAR,NVAR)-VMAX)                               00183000 T  0258
      IF(FLEVL-FIN)600,600,470                                          00184000 T  0262
C     INITIALIZE FOR ENTRY OF VARIABLE K INTO EQUATION.                 00185000 T  0263
  470 K=NMAX                                                            00186000 T  0266
      NENT=K                                                            00187000 T  0266
      GO TO 500                                                         00188000 T  0267
C     OUTPUT FOR VARIABLE DELETED                                       00189000 T  0267
  480 WRITE(3,64)NSTEP,K                                                00190000 T  0269
   64 FORMAT("OSTEP NUMBER ",I2,10X,"DELETE VARIABLE ",I2)              00191000 T  0281
      GO TO 425                                                         00192000 T  0281
C                                                                       00193000 T  0281
C     UPDATE MATRIX                                                     00194000 T  0281
  500 STDEE=1.0/RIJ(K,K)                                                00195000 T  0282
      DO 540 I=1,NVAR                                                   00196000 T  0286
      IF(I-K)510,540,510                                                00197000 T  0293
  510 DO 530 J=1,NVAR                                                   00198000 T  0297
      IF(J-K)520,530,520                                                00199000 T  0303
  520 RIJ(I,J)=RIJ(I,J)-RIJ(I,K)*RIJ(K,J)*STDEE                         00200000 T  0307
  530 CONTINUE                                                          00201000 T  0317
  540 CONTINUE                                                          00202000 T  0318
      DO 560 J=1,NVAR                                                   00203000 T  0318
      IF(J-K)550,560,550                                                00204000 T  0324
  550 RIJ(K,J)=RIJ(K,J)*STDEE                                           00205000 T  0328
  560 CONTINUE                                                          00206000 T  0333
      DO 580 I=1,NVAR                                                   00207000 T  0333
      IF(I-K)570,580,570                                                00208000 T  0339
  570 RIJ(I,K)=-RIJ(I,K)*STDEE                                          00209000 T  0343
  580 CONTINUE                                                          00210000 T  0349
      RIJ(K,K)=STDEE                                                    00211000 T  0349
      GO TO 200                                                         00212000 T  0352
C                                                                       00213000 T  0352
  600 IF(IRES)610,640,610                                               00214000 T  0353
C     PRINT RESIDUALS                                                   00215000 T  0353
  610 IFA=2                                                             00216000 T  0356
      WRITE (3,3000)                                                    00216100 R  0356   PATCH
      WRITE(3,67)                                                       00217000 T  0360
   67 FORMAT("0 OBS        ACTUAL      ESTIMATE     RESIDUAL")          00218000 T  0364
      DO 630 K=1,NOBS                                                   00219000 T  0364
      READ (1"K) (DATA(I), I=1,NVAR)                                    00220000 T  0369
      EST=BSUBO                                                         00221000 T  0387
      DO 620 I=1,NIN                                                    00222000 T  0388
      J=ID(I)                                                           00223000 T  0393
  620 EST=EST+B(I)*DATA(J)                                              00224000 T  0396
      RESID=DATA(NVAR)-EST                                              00225000 T  0399
      RPLOT (K)=RESID                                                   00225100 R  0402   PATCH
      WRITE(3,68)K,DATA(NVAR),EST,RESID                                 00226000 T  0403
   68 FORMAT(" ",I4,3F12.2)                                             00227000 T  0421
  630 CONTINUE                                                          00228000 T  0421
      IF (NPLOT.EQ.1) CALL PLOT(RPLOT,NVAR,NOBS)                        00228100 R  0421   PATCH
C---   NORMAL END OF PROGRAM                                            00229000 T  0425
  640 STOP                                                              00230000 T  0426
 1000 CALL ERROR(1)                                                     00231000 T  0428
 1010 CALL ERROR(2)                                                     00232000 T  0429
 1020 CALL ERROR(3)                                                     00233000 T  0430
      END                                                               00234000 T  0430
                                                                        SEGMENT    4 IS   456 LONG
```

```
                                                           START OF SEGMENT **********   5
      SUBROUTINE ERROR( I )                                     00235000 T  0000
      GO TO (10, 20, 30), I                                     00236000 T  0000
 10   WRITE (3,100)                                             00237000 T  0007
100   FORMAT ("0ERROR... NIN, NENT, VMIN, NCONS, OR NTRAN IS NEGATIVE. 00238000 T  0011
     *CHECK FOR ERROR ON PARAMETER CARDS" )                     00239000 T  0011
      STOP                                                      00240000 T  0011
 20   WRITE (3,200)                                             00241000 T  0013
200   FORMAT ("0ERROR... DEGREES OF FREEDOM = 0.  EITHER ADD MORE OBSERV00242000 T  0017
     *ATIONS OR DELETE ONE OR MORE INDEPENDANT VARIABLE." / " SAMPLE SIZ00243000 T  0017
     *E MUST EXCEED NUMBER OF INDEPENDANT VARIABLES BY AT LEAST 2." )  00244000 T  0017
                                                                SEGMENT     6 IS  118 LONG
      STOP                                                      00245000 T  0017
 30   WRITE (3,300)                                             00246000 T  0019
300   FORMAT ("0ERROR... F LEVEL FOR INCOMING VARIABLE IS LESS THAN F LE00247000 T  0023
     *VEL FOR OUTGOING VARIABLE." )                             00248000 T  0023
      STOP                                                      00249000 T  0023
      END                                                       00250000 T  0024
                                                                SEGMENT     5 IS   30 LONG

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      SUBROUTINE  PLOT(Y,NVAR,NOBS)                             00300000 R  0029  PATCH
                                                           START OF SEGMENT **********   7
      DIMENSION Y(NOBS),X(1000),DUMMY(30),GRAPH(50,100)                  R  0000  PATCH
      NX=80                                                              R  0000  PATCH
      NY=20                                                              R  0000  PATCH
C-----CALCULATE THE MAXIMUM AND MINIMUM OF ORDINATE Y                     R  0000  PATCH
      CALL MAXMIN(Y,NOBS,YMAX,YMIN)                                      R  0001  PATCH
      YFACT=(YMAX-YMIN)/(NY-1)                                           R  0003  PATCH
C-----ONE LOOP FOR EACH GRAPH                                            R  0005  PATCH
      DO 500 J=1,NVAR                                                    R  0006  PATCH
      WRITE(3,3000)                                                      R  0011  PATCH
3000  FORMAT("1")                                                        R  0015  PATCH
C-----READ IN VARIABLE J                                                 R  0016  PATCH
      DO 50 I=1,NOBS                                                     R  0016  PATCH
      READ (1"I)(DUMMY(L),L=1,NVAR)                                      R  0021  PATCH
      X(I)=DUMMY(J)                                                      R  0039  PATCH
50    CONTINUE                                                           R  0041  PATCH
C-----NOW FIND THE MAIMUM AND MINIMUM OF X                               R  0042  PATCH
      CALL MAXMIN(X,NOBS,XMAX,XMIN)                                      R  0042  PATCH
      XFACT=(XMAX-XMIN)/(NX-1)                                           R  0044  PATCH
C---- INITIALISE GRAPH                                                   R  0046  PATCH
      DO 40 I=1,NX+1                                                     R  0047  PATCH
         DO 40 K=1,NY+1                                                  R  0053  PATCH
40    GRAPH (K,I)=0                                                      R  0060  PATCH
C---- PLOT POINTS                                                        R  0065  PATCH
      DO 100 I=1,NOBS                                                    R  0067  PATCH
      NXPOS=IFIX((X(I)-XMIN)/XFACT+0.5)+1                                R  0072  PATCH
      NYPOS=IFIX((Y(I)-YMIN)/YFACT+0.5)+1                                R  0078  PATCH
      GRAPH(NYPOS,NXPOS)=GRAPH(NYPOS,NXPOS)+1                            R  0084  PATCH
100   CONTINUE                                                           R  0094  PATCH
C---- PUT IN X AND Y AXES                                                R  0095  PATCH
      DO 60 I=1,NY                                                       R  0095  PATCH
```

```
      GRAPH(I,1)=13                                            R 0100  PATCH
60    CONTINUE                                                 R 0105  PATCH
      DO 70 I=1,NX                                             R 0105  PATCH
         GRAPH(1,I)=44                                         R 0110  PATCH
70    CONTINUE                                                 R 0115  PATCH
C---- NOW PRINT THE GRAPH                                      R 0116  PATCH
      DO 120 II=1,NY+1                                         R 0116  PATCH
         DO 120 JJ = 1,NX+1                                    R 0122  PATCH
            IF(GRAPH(II,JJ).EQ.0)GRAPH(II,JJ)=48               R 0129  PATCH
120   CONTINUE                                                 R 0140  PATCH
      DO 200 I=1,NY+1                                          R 0142  PATCH
         II=NY-I+2                                             R 0148  PATCH
         WRITE(3,1000)(GRAPH(II,K),K=1,NX+1)                   R 0150  PATCH
1000  FORMAT(1X,130C1)                                         R 0172  PATCH
200   CONTINUE                                                 R 0173  PATCH
C---- PRINT OUT GRAPH DATA                                     R 0173  PATCH
      WRITE(3,2000)J,XMIN,XMAX,XFACT,YMIN,YMAX,YFACT,NOBS      R 0173  PATCH
2000  FORMAT(" GRAPH OF VARIABLE",I4," VS. RESIDUALS "//       R 0197  PATCH
     -" X-AXIS BOUNDS ARE:",F12.6,3X,F12.6,"     X INCREMENT =",F12.6/   R 0198  PATCH
     -" Y-AXIS BOUNDS ARE:",F12.6,3X,F12.6,"     Y INCREMENT =",F12.6/   R 0198  PATCH
     -" NO. OF OBSERVATIONS = ",I4)                            R 0198  PATCH
500   CONTINUE                                                 R 0198  PATCH
      RETURN                                                   R 0198  PATCH
      END                                                      R 0201  PATCH
                                                  SEGMENT    7 IS   221 LONG

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      SUBROUTINE MAXMIN (A,N,RMAX,RMIN)               00500000 R 0220  PATCH
                                           START OF SEGMENT **********   8
      DIMENSION A(N)                                           R 0000  PATCH
      RMAX=-1E40                                               R 0000  PATCH
      RMIN=1E40                                                R 0002  PATCH
      DO 100 J=1,N                                             R 0005  PATCH
      IF(A(J).GT.RMAX)RMAX=A(J)                                R 0010  PATCH
      IF(A(J).LT.RMIN)RMIN=A(J)                                R 0015  PATCH
100   CONTINUE                                                 R 0020  PATCH
      RMAX = IFIX(RMAX+1)                                      R 0021  PATCH
      RMIN = IFIX(RMIN-1)                                      R 0023  PATCH
      RETURN                                                   R 0025  PATCH
      END                                                      R 0028  PATCH
                                                  SEGMENT    8 IS    39 LONG

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                                              99999999 R 0038  PATCH
                                                  SEGMENT    9 IS    80 LONG
                                                  SEGMENT   10 IS    29 LONG
                                                  SEGMENT   11 IS   138 LONG
                                           START OF SEGMENT **********  12
                                                  SEGMENT   12 IS    16 LONG

NUMBER OF CARDS = 366               CORE MEMORY ALLOCATION = 8512 WORDS.
```

MLINEAR/PSPHANS

```
$ SET TAPE LISTP                                                          R  0000
FILE  2 = INPUT              ,UNIT = READER                      00000000 T  0000
FILE  3 = OUTPUT             ,UNIT = PRINTER                     00001000 T  0000
FILE  1=LINEAR/REGRESS, UNIT=DISK,  RANDOM, AREA=1001, RECORD=30 00002000 T  0000
C                                                                00003000 T  0000
C        ------------------------------------------              00004000 T  0000
C        MULTIPLE LINEAR REGRESSION - INPUT PHASE                00005000 T  0000
C        ------------------------------------------              00006000 T  0000
                                                       START OF SEGMENT **********  1
      COMMON I1, R1(30,30), R2(30), R3(30), R4                   00007000 T  0000
      COMMON NPLOT, QUADRT(6,7),RSUBO                            00007100 R  0000  PATCH
      COMMON COEFF(30),NSQU,NDEP,DEP(20),DPGRPH(20),SQGRAF(50,100)        R  0000  PATCH
      DIMENSION X(60,30),NAME(10)   , SQUVN(10)                  00008000 R  0000  PATCH
      READ (2,100) NOBS,NVAR,NSQU,NDEP                           00009000 R  0000  PATCH
100   FORMAT (4I5)                                               00010000 R  0017  PATCH
      READ (2,150) NAME                                          00011000 R  0018  PATCH
150   FORMAT (10A6)                                              00012000 R  0028  PATCH
      READ (2,200)  (SQUVN(I),I=1,NSQU)                          00013000 R  0029  PATCH
200   FORMAT (6I3)                                               00013100 R  0047  PATCH
      READ (2,110) (DEP(I),I=1,NDEP)                                      R  0047  PATCH
110   FORMAT (20F3.0)                                                     R  0069  PATCH
      READ (2,115) (DPGRPH(I),I=1,NDEP)                                   R  0069  PATCH
115   FORMAT(20A1)                                                        R  0091  PATCH
      WRITE(3,953)                                                        R  0091  PATCH
953   FORMAT(10X,"PERSONALITY CORRELATES TO PERFORMANCE UNDER STRESS",10  R  0094  PATCH
     -X,"H.P.LEHMANN",//)                                                 R  0095  PATCH
      WRITE (3,958)                                                       R  0095  PATCH
958    FORMAT (10X,"ORIGINAL DATA MATRIX",/)                              R  0098  PATCH
      WRITE(3,954)                                                        R  0099  PATCH
954   FORMAT (3X,"OBS.NO.","PF/A"1X,"PF/B",1X,"PF/C",1X,"PF/E",1X,"PF/F"  R  0102  PATCH
     -,1X,"PF/G",1X,"PF/H",1X,"PF/I",1X,"PF/L",1X,"PF/M",1X,"PF/N",1X,"PF/ R  0103  PATCH
     -F/O",1X,"P/Q1",1X,"PFQ2",1X,"P/Q3",1X,"P/Q4",1X,"STATE","TRAIT",1X  R  0103  PATCH
     -,"INT.",1X,"AGE",2X,"EXP.",1X,"SCORE")                              R  0103  PATCH
      DO 10 K=1,NOBS                                             00014000 R  0103  PATCH
         READ (2,250) (X(K,J),J=1,NVAR)                          00015000 R  0108  PATCH
955   FORMAT (I10,19F5.0,10X,1F5.0)                                       R  0130  PATCH
      WRITE (3,955) K,(X(K,J),J=1,NVAR)                                   R  0130  PATCH
250      FORMAT (19F3.0,6X,1F3.0)                                00016000 R  0153  PATCH
         DEPVAR = X(K,NVAR)                                      00017000 R  0153  PATCH
         I=1                                                     00018000 R  0158  PATCH
         DO 20 J = 1, NVAR                                       00019000 R  0158  PATCH
              IF ( J.NE.SQUVN(I)) GO TO 20                       00020000 R  0164  PATCH
              X(K,I) = X(K,J)                                    00021000 R  0167  PATCH
            X(K,I+NSQU) = X(K,J) **2                             00022000 R  0177  PATCH
            I=I+1                                                         R  0188  PATCH
20       CONTINUE                                                00023000 R  0190  PATCH
         J = 2*NSQU                                              00024000 R  0190  PATCH
           DO 30 M=1,NSQU -1                                     00025000 R  0192  PATCH
             DO 40 N = M+1,NSQU                                  00026000 R  0200  PATCH
                J = J + 1                                                 R  0207  PATCH
                X (K,J) = X(K,M) * X(K,N)                                 R  0209  PATCH
40            CONTINUE                                                    R  0223  PATCH
30            CONTINUE                                                    R  0224  PATCH
         X(K,J+1) = DEPVAR                                                R  0225  PATCH
10    CONTINUE                                                            R  0231  PATCH
      NVAR = J + 1                                                        R  0232  PATCH
      WRITE (1"0) NOBS,NVAR,NAME                                          R  0233  PATCH
```



APP. E.3
FORTRAN-PROGRAM USED FOR THE RSA's

1

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      DO 45 J = 1,NOBS                                                           R  0248  PATCH
45    WRITE (1"J) (X(J,I),I=1,NVAR)                                              R  0253  PATCH
C---- NOW CALL THE SUBROUTINE THAT DOES ALL THE LINEAR REGRESSING     00027000 T  0271
      CALL REGR1                                                      00028000 T  0275
C==== READ THE "F VALUES" FOR VARIABLES (1) TO ENTER, & (2) TO LEAVE  00029000 T  0275
C     THE REGRESSION EQUATION, AND AN OPTION TO PRINT THE RESIDUALS.  00030000 T  0275
      READ (2,300,END=50)FIN,FOUT,IRES,NPLOT                          00031000 R  0276  PATCH
300   FORMAT(2F10.5,2I2)                                              00032000 R  0293  PATCH
      WRITE  (3,3001)                                                          R  0294  PATCH
3001  FORMAT ( 10X," MULTIPLE QUADRATIC REGRESSION")                           R  0297  PATCH
      WRITE (3,3002)                                                           R  0298  PATCH
3002  FORMAT (10X,"------------------------------")                            R  0301  PATCH
      CALL REGR2 ( FIN, FOUT, IRES )                                  00033000 T  0302
      STOP                                                            00034000 T  0303
  50  CALL REGR2 ( 0.0, 0.0, 1 )                                      00035000 T  0305
C-----NOW START PLOTTING                                               00035100 R  0306  PATCH
      WRITE(3,9000) (COEFF(I),I=1,NVAR)                                        R  0306  PATCH
9000  FORMAT(F7.4,///)                                                         R  0327  PATCH
      HEIN=2*NSQU                                                              R  0327  PATCH
      DO 61 J=1,NSQU                                                           R  0329  PATCH
      QUADRT(J,J)=COEFF(J+NSQU)                                                R  0335  PATCH
      DO 62 K=J,NSQU-1                                                         R  0345  PATCH
      HEIN = HEIN+1                                                            R  0353  PATCH
      QUADRT (J,K+1)=COEFF(HEIN)                                               R  0355  PATCH
62    CONTINUE                                                                 R  0364  PATCH
61    CONTINUE                                                                 R  0364  PATCH
      DO 7000 J=U,NSQU                                                         R  0365  PATCH
      WRITE (3,9001)(QUADRT(J,I),I=1,NSQU)                                     R  0371  PATCH
7000  CONTINUE                                                                 R  0394  PATCH
9001  FORMAT (F7.4)                                                            R  0394  PATCH
C-----DRAW ONE GRAPH FOR EACH COMBINATION OF VARIABLES                         R  0395  PATCH
      DO 63 M=1,NSQU-1                                                         R  0395  PATCH
      DO 64 N=M+1,NSQU                                                         R  0402  PATCH
C-----NOW INITIATE FOR THE GRAPHS                                              R  0404  PATCH
      DO 65 I=1,50                                                             R  0409  PATCH
      DO 66 J=1,100                                                            R  0415  PATCH
      SQGRAF(I,J)=" "                                                          R  0421  PATCH
      SQGRAF(1,J)="-"                                                          R  0430  PATCH
      SQGRAF(50,J)="-"                                                         R  0438  PATCH
      SQGRAF(I,1)="!"                                                          R  0446  PATCH
      SQGRAF(I,100)="!"                                                        R  0454  PATCH
66    CONTINUE                                                                 R  0462  PATCH
65    CONTINUE                                                                 R  0463  PATCH
C-----DRAW ALL THE SELECTED RESPONSE LEVELS IN ONE GRAPH                       R  0464  PATCH
      DO 67 I=1,NDEP                                                           R  0464  PATCH
C------ONE LOOP FOR EACH GRAPH                                                 R  0465  PATCH
      DO 68 K = 1,100                                                          R  0470  PATCH
      X2 = FLOAT(K/10)                                                         R  0476  PATCH
C-----FIND THE ROOTS: DEP,X2 IS GIVEN, FIND X1                                 R  0477  PATCH
      C=(BSUBO-DEP(I)+COEFF(N)*X2+QUADRT(N,N)*(X2**2))/QUADRT(M,M)             R  0478  PATCH
      B=(COEFF(M)+QUADRT(M,N)*X2)/QUADRT(M,M)                                  R  0500  PATCH
      DISCR=B**2-4*C                                                           R  0514  PATCH
C-----CHECK FOR COMPLEX ROOTS                                                  R  0515  PATCH
      IF (DISCR.LT.0) GO TO 68                                                 R  0516  PATCH
      TERM=-B/2                                                                R  0519  PATCH
      COMP=SQRT(DISCR)/2                                                       R  0520  PATCH
C-----CHECK IF THE ROOTS ARE OUTSIDE THE GRAPH BOUNDARIES                      R  0521  PATCH
      DO 69 Z=0.,2.,2.                                                         R  0522  PATCH
      YPOS=IFIX((TERM+COMP*(Z-1.))*5.+0.5)                                     R  0527  PATCH
      IF ((YPOS.LT.0).OR.(YPOS.GE.50)) GO TO 69                                R  0533  PATCH
C-----FILL GRAPH ARRAY (SQGRAF) WITH RESPONSE-SYMBOLS (DPGRPH)                 R  0535  PATCH
      SQGRAF(YPOS,K)=DPGRPH(I)                                                 R  0536  PATCH
69    CONTINUE                                                                 R  0548  PATCH
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68     CONTINUE                                                                    R  0549   PATCH
67     CONTINUE                                                                    R  0550   PATCH
       WRITE (3,3000)                                                              R  0551   PATCH
3000   FORMAT("1")                                                                 R  0555   PATCH
C-----PRINT THE GRAPH                                                              R  0555   PATCH
       DO 70 K=1,50                                                                R  0555   PATCH
       KK=50-K+1                                                                   R  0560   PATCH
       WRITE (3,750) (SQGRAF(KK,L),L=1,100)                                        R  0562   PATCH
750    FORMAT(15X,100A1)                                                           R  0585   PATCH
70     CONTINUE                                                                    R  0585   PATCH
C-----WRITE THE GRAPH-COMMENT                                                      R  0585   PATCH
       WRITE (3,751) M                                                             R  0585   PATCH
751    FORMAT(15X,"RESPONSE SURFACE OF VARIABLE ",I2," ON THE Y-AXIS")             R  0595   PATCH
                                                                       SEGMENT    2 IS  125 LONG
       WRITE(3,752) N                                                              R  0596   PATCH
752    FORMAT(31X,"AND VARIABLE ",I2," ON THE X-AXIS"/)                            R  0605   PATCH
       WRITE (3,753)                                                               R  0606   PATCH
753    FORMAT(15X,"KEY TO CONTOUR HEIGHTS (RESPONSE LEVELS):")                     R  0609   PATCH
       WRITE (3,754)(DPGRPH(I),I=1,NDEP)                                           R  0610   PATCH
754    FORMAT (15X,"SYMBOLS:",20A5)                                                R  0632   PATCH
       WRITE (3,755)(DEP(I),I=1,NDEP)                                              R  0632   PATCH
755.   FORMAT (15X,"RESP.L.:",20I5)                                                R  0654   PATCH
64     CONTINUE                                                                    R  0654   PATCH
63     CONTINUE                                                                    R  0654   PATCH
       STOP                                                              00036000 T  0655
       END                                                               00037000 T  0657
C                                                                        00038000 T  0657
C                                                                        00039000 T  0657
                                                                       SEGMENT    1 IS  674 LONG

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                                                                 START OF SEGMENT **********    3
       SUBROUTINE REGR1                                                  00040000 T  0000
C---   MULTIPLE LINEAR REGRESSION - PHASE 1                              00041000 T  0000
       COMMON NVAR, R(30,30), XBAR(30), SIGMA(30), OBS                   00042000 T  0000
       DIMENSION  X(30), NAME(10)                                        00043000 T  0000
C                                                                        00044000 T  0000
       READ (1"0) NOBS, NVAR, NAME                                       00045000 T  0000
       OBS=NOBS                                                          00046000 T  0017
       DO 2 J=1,NVAR                                                     00047000 T  0019
       XBAR(J)=0.                                                        00048000 T  0025
       DO 2 K=1,NVAR                                                     00049000 T  0030
     2 R(J,K)=0.                                                         00050000 T  0037
       DO 3 I=1,NOBS                                                     00051000 T  0043
       READ (1"I)  X                                                     00052000 T  0048
       DO 4 J=1,NVAR                                                     00053000 T  0061
       XBAR(J)=XBAR(J)+X(J)                                              00054000 T  0067
       DO 4 K=1,J                                                        00055000 T  0076
       R(J,K)=R(J,K)+X(J)*X(K)                                           00056000 T  0081
     4 R(K,J)=R(J,K)                                                     00057000 T  0094
     3 CONTINUE                                                          00058000 T  0105
       DO 5 J=1,NVAR                                                     00059000 T  0105
     5 SIGMA(J)=SQRT(R(J,J)-XBAR(J)*XBAR(J)/OBS)                         00060000 T  0112
       DO 6 J=1,NVAR                                                     00061000 T  0130
       DO 6 K=1,J                                                        00062000 T  0136
       R(J,K)=(R(J,K)-XBAR(J)*XBAR(K)/OBS)/(SIGMA(J)*SIGMA(K))           00063000 T  0142
     6 R(K,J)=R(J,K)                                                     00064000 T  0169
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      DEN=SQRT(OBS-1.)                                                   00065000 T  0179
      DO 7 J=1,NVAR                                                      00066000 T  0182
      XBAR(J)=XBAR(J)/OBS                                                00067000 T  0188
    7 SIGMA(J)=SIGMA(J)/DEN                                              00068000 T  0198
      WRITE (3,3000)                                                     00068100 R  0206   PATCH
 3000 FORMAT ("1")                                                                R  0210   PATCH
      WRITE(3,200)NAME                                                   00069000 T  0210
  200 FORMAT ( 11X, 10A6 // )                                            00070000 T  0223
      WRITE(3,201)                                                       00071000 T  0223
  201 FORMAT(1H0" VAR        MEAN    STD DEV"/)                          00072000 T  0227
      WRITE(3,202)(J,XBAR(J),SIGMA(J),J=1,NVAR)                          00073000 T  0227
  202 FORMAT(1X,I4,2F10.2)                                               00074000 T  0256
      WRITE(3,203)                                                       00075000 T  0256
  203 FORMAT(1H0,10X,"SIMPLE CORRELATION CO-EFFICIENTS")                 00076000 T  0260
      DO 10 J=1,NVAR                                                     00077000 T  0260
   10 WRITE(3,204)(J,K,R(J,K),K=1,NVAR)                                  00078000 T  0267
  204 FORMAT(6(2I4,F8.4,4X))                                             00079000 T  0294
C     CALL LINK(REGR2)                                                   00080000 T  0294
      RETURN                                                             00081000 T  0294
      END                                                                00082000 T  0297
C                                                                        00083000 T  0297
C                                                                        00084000 T  0297
C                                                                        00085000 T  0297
C                                                                        00086000 T  0297
C                                                                        00087000 T  0297
C                                                                        00088000 T  0297
C                                                                        00089000 T  0297
                                                                        SEGMENT    3 IS  307 LONG

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                                                                    START OF SEGMENT **********    4
      SUBROUTINE REGR2 ( FIN, FOUT, IRES )                               00090000 T  0000
C---  MULTIPLE LINEAR REGRESSION - PHASE 2                                00091000 T  0000
      COMMON  NVAR, RIJ(30,30), XBAR(30), SIGMA(30), OBS                  00092000 T  0000
      COMMON   NPLOT  ,  COEFF(30)                                       00092100 R  0000   PATCH
      DIMENSION SIGB(30), B(30), ID(30), DATA(30)                         00093000 T  0000
      DIMENSION RPLOT(1000)                                              00093100 R  0000   PATCH
C                                                                        00094000 T  0000
      NINDV=NVAR-1                                                       00095000 T  0000
      NOBS=OBS                                                           00096000 T  0002
C     PHASE 2, PERFORM STEPWISE CALCULATIONS AND PRINT RESULTS.          00097000 T  0002
C     DIMENSIONS                                                         00098000 T  0002
C     INITIALIZE                                                         00099000 T  0002
      DO 190 I=1,NVAR                                                    00100000 T  0004
      SIGB(I)=0.0                                                        00101000 T  0010
  190 B(I)=0.0                                                           00102000 T  0013
      NENT=0                                                             00103000 T  0015
      DF=OBS-1.0                                                         00104000 T  0016
      NSTEP=-1                                                           00105000 T  0019
C     TRANSFORM SIGMA VECTOR FROM STANDARD DEVIATIONS TO SQUARE           00106000 T  0019
C     ROOTS OF SUMS OF SQUARES.                                          00107000 T  0019
      DO 310 I=1,NVAR                                                    00108000 T  0020
  310 SIGMA(I)=SIGMA(I)*SQRT(OBS-1.0)                                    00109000 T  0028
C                                                                        00110000 T  0039
C     BEGIN STEP NUMBER NSTEP.                                           00111000 T  0039
  200 NSTEP=NSTEP+1                                                      00112000 T  0041
      WRITE (3,3000)                                                     00112100 R  0042   PATCH
```

```
 3000  FORMAT("1")                                                          R  0045  PATCH
       STDEE=SQRT(RIJ(NVAR,NVAR)/DF) * SIGMA(NVAR)                  00113000 T  0046
       DF=DF-1.0                                                    00114000 T  0058
       IF(DF)1010,1010,205                                          00115000 T  0061
  205  VMIN=0.0                                                     00116000 T  0064
       VMAX=0.0                                                     00117000 T  0064
       NIN=0                                                        00118000 T  0065
C      FIND MINIMUM VARIANCE CONTRIBUTION OF VARIABLES IN REGRESSION 00119000 T  0065
C      EQUATION. FIND MAXIMUM VARIANCE CONTRIBUTION OF VARIABLES    00120000 T  0065
C      NOT IN REGRESSION EQUATION.                                  00121000 T  0065
       DO 300 I=1,NINDV                                             00122000 T  0066
       IF(RIJ(I,I)-.001)300,300,210                                 00123000 T  0071
  210  VI=RIJ(I,NVAR)*RIJ(NVAR,I)/RIJ(I,I)                          00124000 T  0081
       IF(VI)240,300,220                                            00125000 T  0097
  220  IF(VI-VMAX)300,300,230                                       00126000 T  0103
  230  VMAX=VI                                                      00127000 T  0106
       NMAX=I                                                       00128000 T  0106
       GO TO 300                                                    00129000 T  0107
  240  NIN=NIN+1                                                    00130000 T  0109
       ID(NIN)=I                                                    00131000 T  0110
C      COMPUTE REGRESSION COEFFICIENT AND ITS STANDARD DEVIATION.   00132000 T  0111
       B(NIN)=RIJ(I,NVAR)*SIGMA(NVAR)/SIGMA(I)                      00133000 T  0112
       SIGB(NIN)=STDEE*SQRT(RIJ(I,I))/SIGMA(I)                      00134000 T  0127
       IF(VMIN)250,260,1000                                         00135000 T  0138
  250  IF(VI-VMIN)300,300,260                                       00136000 T  0143
  260  VMIN=VI                                                      00137000 T  0146
       NMIN=I                                                       00138000 T  0146
  300  CONTINUE                                                     00139000 T  0148
       IF(NIN)1000,460,400                                          00140000 T  0148
C      COMPUTE CONSTANT TERM.                                       00141000 T  0148
  400  BSUBO=XBAR(NVAR)                                             00142000 T  0154
       DO 410 I=1,NIN                                               00143000 T  0159
       J=ID(I)                                                      00144000 T  0164
  410  BSUBO=BSUBO-B(I)*XBAR(J)                                     00145000 T  0167
       IF(NENT)1000,480,420                                         00146000 T  0173
C      OUTPUT FOR VARIABLE ADDED                                    00147000 T  0173
  420  WRITE(3,57)NSTEP,K                                           00148000 T  0178
   57  FORMAT("OSTEP NUMBER ",I2,10X,"ENTER VARIABLE ",I2)          00149000 T  0190
  425  WRITE(3,58)STDEE                                             00150000 T  0190
   58  FORMAT(" STANDARD ERROR OF ESTIMATE=",F11.3)                 00151000 T  0200
       R=SQRT(1.0-RIJ(NVAR,NVAR))                                   00152000 T  0200
       WRITE(3,59)R                                                 00153000 T  0209
   59  FORMAT(" MULTIPLE CORRELATION COEFFICIENT =",F6.3)           00154000 T  0220
       IDFN=OBS-DF-2.0                                              00155000 T  0220
       IDFD=DF+1.0                                                  00156000 T  0225
C-------------------------------------------------------------------- 00157000 R  0225  PATCH
C      EXPRESS GOODNESS OF FIT AS PERCENTAGE-FIT, GIVING THE RATIO OF         R  0225  PATCH
C      SUMS OF SQUARES DUE TO REGRESSION VERSUS THE TOTAL SUM OF SQUARES      R  0225  PATCH
C-------------------------------------------------------------------- 00158000 R  0225  PATCH
       FIT= (R**2)*100                                                       R  0229  PATCH
       WRITE (3,66) FIT                                             00159000 R  0231  PATCH
 66    FORMAT (1X,"GOODNESS OF FIT:",F8.4,"%")                      00160000 R  0240  PATCH
       WRITE(3,60)BSUBO                                             00161000 T  0241
   60  FORMAT(" CONSTANT TERM=",F12.4)                              00162000 T  0251
       WRITE(3,61)                                                  00163000 T  0251
 61    FORMAT (3X,"VAR",5X,"COEFF",5X,"STD DEV",4X,"F-RATIO",1X,"BETA COE00164000 R  0254  PATCH
      -FF")                                                                  R  0255  PATCH
                                                           SEGMENT    5 IS  117 LONG
       WRITE(3,62)                                                  00165000 T  0255
 62    FORMAT (23X,"COEFF",2X,"VAR.CONTR")                          00166000 R  0258  PATCH
       DO 430 I=1,NIN                                               00167000 T  0259
       J=ID(I)                                                      00168000 T  0264
       T=B(I)/SIGB(I)                                               00169000 T  0266
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C-------------------------------------------------------------------- 00169050 R  0267  PATCH
C     INSTEAD OF USING THE RAW T-VALUE USE T T-SQU. AS F-RATIO FOR THE 00169100 R  0267  PATCH
C     SIGNIFICANCE OF THE CONTRIBUTION OF VARIABLES TO THE OVERALL FIT         R  0267  PATCH
C--------------------------------------------------------------------          R  0267  PATCH
      T=T**2                                                                   R  0269  PATCH
  430 WRITE(3,63)ID(I),B(I),SIGB(I),T,RIJ(J,NVAR)                      00170000 T  0271
63    FORMAT (3X,I3,4E11.4)                                            00171000 R  0298  PATCH
      COEFF(J)=B(I)                                                    00171100 R  0298  PATCH
C     COMPUTE F LEVEL FOR MINIMUM VARIANCE CONTRIBUTION VARIABLE       00172000 T  0301
C     IN REGRESSION EQUATION.                                          00173000 T  0301
      FLEVL=VMIN*DF/RIJ(NVAR,NVAR)                                     00174000 T  0303
      IF(FOUT+FLEVL)460,460,450                                        00175000 T  0311
C     INITIALIZE FOR REMOVAL OF VARIABLE K FROM EQUATION.              00176000 T  0311
  450 K=NMIN                                                           00177000 T  0314
      NENT=0                                                           00178000 T  0314
      DF=DF+2.0                                                        00179000 T  0315
      GO TO 500                                                        00180000 T  0318
C     COMPUTE F LEVEL FOR MAXIMUM VARIANCE CONTRIBUTION VARIABLE       00181000 T  0318
C     NOT IN EQUATION.                                                 00182000 T  0318
  460 FLEVL=VMAX*DF/(RIJ(NVAR,NVAR)-VMAX)                              00183000 T  0320
      IF(FLEVL-FIN)600,600,470                                         00184000 T  0328
C     INITIALIZE FOR ENTRY OF VARIABLE K INTO EQUATION.                00185000 T  0329
  470 K=NMAX                                                           00186000 T  0332
      NENT=K                                                           00187000 T  0332
      GO TO 500                                                        00188000 T  0333
C     OUTPUT FOR VARIABLE DELETED                                      00189000 T  0333
  480 WRITE(3,64)NSTEP,K                                               00190000 T  0335
   64 FORMAT("OSTEP NUMBER ",I2,10X,"DELETE VARIABLE ",I2)             00191000 T  0347
      GO TO 425                                                        00192000 T  0347
C                                                                      00193000 T  0347
C     UPDATE MATRIX                                                    00194000 T  0347
  500 STDEE=1.0/RIJ(K,K)                                               00195000 T  0348
      DO 540 I=1,NVAR                                                  00196000 T  0355
      IF(I-K)510,540,510                                               00197000 T  0361
  510 DO 530 J=1,NVAR                                                  00198000 T  0365
      IF(J-K)520,530,520                                               00199000 T  0371
  520 RIJ(I,J)=RIJ(I,J)-RIJ(I,K)*RIJ(K,J)*STDEE                        00200000 T  0375
  530 CONTINUE                                                         00201000 T  0395
  540 CONTINUE                                                         00202000 T  0396
      DO 560 J=1,NVAR                                                  00203000 T  0396
      IF(J-K)550,560,550                                               00204000 T  0402
  550 RIJ(K,J)=RIJ(K,J)*STDEE                                          00205000 T  0406
  560 CONTINUE                                                         00206000 T  0416
      DO 580 I=1,NVAR                                                  00207000 T  0416
      IF(I-K)570,580,570                                               00208000 T  0422
  570 RIJ(I,K)=-RIJ(I,K)*STDEE                                         00209000 T  0426
  580 CONTINUE                                                         00210000 T  0437
      RIJ(K,K)=STDEE                                                   00211000 T  0437
      GO TO 200                                                        00212000 T  0442
C                                                                      00213000 T  0442
  600 IF(IRES)610,640,610                                              00214000 T  0444
C     PRINT RESIDUALS                                                  00215000 T  0444
  610 IFA=2                                                            00216000 T  0447
      WRITE (3,3000)                                                   00216100 R  0447  PATCH
      WRITE(3,67)                                                      00217000 T  0451
   67 FORMAT("0 OBS       ACTUAL     ESTIMATE     RESIDUAL")           00218000 T  0455
      DO 630 K=1,NOBS                                                  00219000 T  0455
      READ (1'K) (DATA(I), I=1,NVAR)                                   00220000 T  0460
      EST=BSUBO                                                        00221000 T  0479
      DO 620 I=1,NIN                                                   00222000 T  0479
      J=ID(I)                                                          00223000 T  0485
  620 EST=EST+B(I)*DATA(J)                                             00224000 T  0488
      RESID=DATA(NVAR)-EST                                             00225000 T  0491
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      RPLOT (K)=RESID                                                   00225100 R  0494   PATCH
      WRITE(3,68)K,DATA(NVAR),EST,RESID                                 00226000 T  0496
   68 FORMAT(" ",I4,3F12.2)                                             00227000 T  0515
  630 CONTINUE                                                          00228000 T  0515
      IF (NPLOT.EQ.1) CALL PLOT(RPLOT,NVAR,NOBS)                        00228100 R  0515   PATCH
C---   NORMAL END OF PROGRAM                                            00229000 T  0520
640   RETURN                                                            00230000 R  0521   PATCH
 1000 CALL ERROR(1)                                                     00231000 T  0524
 1010 CALL ERROR(2)                                                     00232000 T  0525
 1020 CALL ERROR(3)                                                     00233000 T  0526
        END                                                             00234000 T  0526
                                                                       SEGMENT    4 IS  552 LONG

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                                                              START OF SEGMENT **********    6
      SUBROUTINE ERROR( I )                                            00235000 T  0000
      GO TO (10, 20, 30), I                                             00236000 T  0000
   10 WRITE (3,100)                                                     00237000 T  0007
  100 FORMAT ("0ERROR... NIN, NENT, VMIN, NCONS, OR NTRAN IS NEGATIVE.  00238000 T  0011
     *CHECK FOR ERROR ON PARAMETER CARDS" )                             00239000 T  0011
      STOP                                                              00240000 T  0011
   20 WRITE (3,200)                                                     00241000 T  0013
  200 FORMAT ("0ERROR... DEGREES OF FREEDOM = 0.  EITHER ADD MORE OBSERV00242000 T  0017
     *ATIONS OR DELETE ONE OR MORE INDEPENDANT VARIABLE." / " SAMPLE SIZ00243000 T  0017
     *E MUST EXCEED NUMBER OF INDEPENDANT VARIABLES BY AT LEAST 2." )   00244000 T  0017
      STOP                                                              00245000 T  0017
   30 WRITE (3,300)                                                     00246000 T  0019
  300 FORMAT ("0ERROR... F LEVEL FOR INCOMING VARIABLE IS LESS THAN F LE00247000 T  0023
     *VEL FOR OUTGOING VARIABLE." )                                     00248000 T  0023
      STOP                                                              00249000 T  0023
      END                                                               00250000 T  0024
                                                                       SEGMENT    6 IS   30 LONG

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      SUBROUTINE  PLOT(Y,NVAR,NOBS)                                     00300000 R  0029   PATCH
                                                              START OF SEGMENT **********    7
      DIMENSION Y(NOBS),X(1000),DUMMY(30),GRAPH(50,100)                          R  0000   PATCH
      NX=80                                                                      R  0000   PATCH
      NY=20                                                                      R  0000   PATCH
C-----CALCULATE THE MAXIMUM AND MINIMUM OF ORDINATE Y                             R  0000   PATCH
      CALL MAXMIN(Y,NOBS,YMAX,YMIN)                                              R  0001   PATCH
      YFACT=(YMAX-YMIN)/(NY-1)                                                   R  0003   PATCH
C-----ONE LOOP FOR EACH GRAPH                                                     R  0005   PATCH
      DO 500 J=1,NVAR                                                            R  0006   PATCH
      WRITE(3,3000)                                                              R  0011   PATCH
3000  FORMAT("1")                                                                R  0015   PATCH
C-----READ IN VARIABLE J                                                         R  0016   PATCH
      DO 50 I=1,NOBS                                                             R  0016   PATCH
      READ (1"I)(DUMMY(L),L=1,NVAR)                                              R  0021   PATCH
      X(I)=DUMMY(J)                                                              R  0039   PATCH
50    CONTINUE                                                                   R  0041   PATCH
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C-----NOW FIND THE MAIMUM AND MINIMUM OF X                              R  0042   PATCH
      CALL MAXMIN(X,NOBS,XMAX,XMIN)                                     R  0042   PATCH
      XFACT=(XMAX-XMIN)/(NX-1)                                          R  0044   PATCH
C---- INITIALISE GRAPH                                                  R  0046   PATCH
      DO 40 I=1,NX+1                                                    R  0047   PATCH
         DO 40 K=1,NY+1                                                 R  0053   PATCH
40    GRAPH (K,I)=0                                                     R  0060   PATCH
C---- PLOT POINTS                                                       R  0065   PATCH
      DO 100 I=1,NOBS                                                   R  0067   PATCH
      NXPOS=IFIX((X(I)-XMIN)/XFACT+0.5)+1                               R  0072   PATCH
      NYPOS=IFIX((Y(I)-YMIN)/YFACT+0.5)+1                               R  0078   PATCH
      GRAPH(NYPOS,NXPOS)=GRAPH(NYPOS,NXPOS)+1                           R  0084   PATCH
100   CONTINUE                                                          R  0094   PATCH
C---- PUT IN X AND Y AXES                                               R  0095   PATCH
      DO 60 I=1,NY                                                      R  0095   PATCH
         GRAPH(I,1)=13                                                  R  0100   PATCH
60    CONTINUE                                                          R  0105   PATCH
      DO 70 I=1,NX                                                      R  0105   PATCH
         GRAPH(1,I)=44                                                  R  0110   PATCH
70    CONTINUE                                                          R  0115   PATCH
C---- NOW PRINT THE GRAPH                                               R  0116   PATCH
      DO 120 II=1,NY+1                                                  R  0116   PATCH
         DO 120 JJ = 1,NX+1                                             R  0122   PATCH
            IF(GRAPH(II,JJ).EQ.0)GRAPH(II,JJ)=48                        R  0129   PATCH
120   CONTINUE                                                          R  0140   PATCH
      DO 200 I=1,NY+1                                                   R  0142   PATCH
         II=NY-I+2                                                      R  0148   PATCH
         WRITE(3,1000)(GRAPH(II,K),K=1,NX+1)                            R  0150   PATCH
1000  FORMAT(1X,130C1)                                                  R  0172   PATCH
200   CONTINUE                                                          R  0173   PATCH
C---- PRINT OUT GRAPH DATA "                                            R  0173   PATCH
      WRITE(3,2000)J,XMIN,XMAX,XFACT,YMIN,YMAX,YFACT,NOBS               R  0173   PATCH
2000  FORMAT(" GRAPH OF VARIABLE",I4," VS. RESIDUALS "//                R  0197   PATCH
     -" X-AXIS BOUNDS ARE:",F12.6,3X,F12.6,"      X INCREMENT =",F12.6/ R  0198   PATCH
     -" Y-AXIS BOUNDS ARE:",F12.6,3X,F12.6,"      Y INCREMENT =",F12.6/ R  0198   PATCH
     -" NO. OF OBSERVATIONS = ",I4)                                     R  0198   PATCH
                                                              SEGMENT    8 IS  110 LONG
500   CONTINUE                                                          R  0198   PATCH
      RETURN                                                            R  0198   PATCH
      END                                                               R  0201   PATCH
                                                              SEGMENT    7 IS  221 LONG

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      SUBROUTINE MAXMIN (A,N,RMAX,RMIN)                        00500000 R  0220   PATCH
                                                     START OF SEGMENT **********    9
      DIMENSION A(N)                                                    R  0000   PATCH
      RMAX=-1E40                                                        R  0000   PATCH
      RMIN=1E40                                                         R  0002   PATCH
      DO 100 J=1,N                                                      R  0005   PATCH
      IF(A(J).GT.RMAX)RMAX=A(J)                                         R  0010   PATCH
      IF(A(J).LT.RMIN)RMIN=A(J)                                         R  0015   PATCH
100   CONTINUE                                                          R  0020   PATCH
      RMAX = IFIX(RMAX+1)                                               R  0021   PATCH
      RMIN = IFIX(RMIN-1)                                               R  0023   PATCH
      RETURN                                                            R  0025   PATCH
      END                                                               R  0028   PATCH
                                                              SEGMENT    9 IS   39 LONG
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Personality Variables

| | | | Var. |
|---|---|---|---|
| A | - | RESERVED/OUTGOING | ( |
| B | - | SCHOLASTIC MENTAL CAPACITY | ( |
| C | - | EGO STRENGTH | ( |
| E | - | DOMINANCE | ( |
| F | - | SOBER/IMPULSILVE | ( |
| G | - | SUPEREGO STRENGTH | ( |
| H | - | SHY/VENTURESOME | ( |
| I | - | TOUGH/TENDER-MINDED | ( |
| L | - | TRUSTING/SUSPICIOUS | ( |
| M | - | PRACTICAL/IMAGINATIVE | ( |
| N | - | ARTLESS/SHREWD | ( |
| O | - | CONFIDENT/APPREHENSIVE | ( |
| Q1 | - | CONSERVATIVE/RADICAL | ( |
| Q2 | - | SELF-SUFFICIENCY | ( |
| Q3 | - | SELF-CONDEPT CONTROL | ( |
| Q4 | - | RELAXED/OVERWROUGHT | ( |
| A-T | - | TRAIT-ANXIETY | ( |
| A-St | - | STATE-ANXIETY | ( |
| INTELLIGENCE (RAVEN's PMT) | | | ( |