Development of a Model for Predicting NASA/MSFC Project Success

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1.0 INTRODUCTION

Research conducted during the execution of a previous contract (NAS8-36955/0039) firmly established the feasibility of developing a tool to aid decision makers in predicting the potential success of proposed projects. The final report from that investigation contains an outline of the method to be applied in developing this Project Success Predictor Model. As a follow-on to the previous study, this report describes in detail the development of this model and includes full explanation of the data-gathering techniques used to poll expert opinion. The report includes the presentation of the model code itself (see APPENDIX A).

The initial task in model development was recruitment of NASA executives, some current, others former, who were to be polled for expert opinion. Three executives provided opinion data for Phase I while four different executives participated in both Phase II and Phase III. All seven experts either are currently employed by NASA/MSFC or had been so employed in the past. Direct involvement by these executives in the projects referenced for opinion data collection was not a requirement. However, most of the seven had in fact been involved with at least one of the referenced projects at some point in their careers.

Questionnaires were developed and submitted to the NASA experts for the purpose of polling their quantitative opinion regarding the success of four manned and five unmanned historical NASA projects. Once collected and analyzed, this data was used

to develop two separate regression equations which compose the basis for the Project Success Predictor Model. This raw data is presented in APPENDIX B.

Subsequent segments of this report contain an explanation of the polling techniques applied, copies of the questionnaires used, and summaries of the projects referenced as well as print-outs of the data collected from the polls and the resulting model as developed.

2.0 MODEL DEVELOPMENT

The opinion data required to formulate the Project Success Predictor Model was collected by employing the Delphi technique. Following each iteration of this method, the Kendall Coefficient of Concordance for Complete Rankings test was applied to ensure that the expert opinions were in agreement. The following is a detailed description of these two techniques.

2.1 Delphi Technique

Delphi inquiry was developed by the RAND Corporation in 1959. The technique is typically a pencil and paper process whereby experts in a particular field are consulted and asked to express opinions which are recorded quantitatively on a monotonic scale. Individual responses, rendered anonymously, are collected and analyzed by the individual conducting the poll. This analysis generally includes an indication of the extreme and mean values of the submitted responses. A revised questionnaire containing the results of this analysis is then developed and distributed to members of the response group to give them an opportunity to re-evaluate their original responses based on the analysis of the results from that round.

Delphi inquiry has many proven historical precedents in weapons deployment and technology trends forecasting. Delphi, as a formal forecasting method, is intended to replace subjective opinion with objective data. This technique works best in situations where: 1) there is a lack of historical

data, 2) external factors are more important than usual factors that governed previous behavior, and 3) ethical considerations dominate economic and technical considerations. These scenarios describe situations which require that an expert be consulted. However, a panel of experts is often employed based on the adage that there is more information in two heads than in one.

The Delphi method uses the views of top management, engineers, and scientists to generate new ideas, different alternatives, and various solution suggestions. Furthermore, Delphi inquiry can be utilized to produce organizational and technological objectives, needs research, technological and environmental forecasts, and to determine a portfolio of projects. The monitoring team designs a questionnaire which is sent to a larger response group to bring together opinions which would otherwise be costly to assemble.

The Delphi technique consists of a combination of conference and polling procedures without the disadvantages associated with either procedure. Formal communication lines are established and monitored without the opinions being shaped by dominant personalities in the group. Moreover, the most important characteristic of the Delphi inquiry is its ability to reflect the opinion of each panel member.

There are some basic pitfalls associated with the technique. They are as follows:

- Groups are often guilty of a short term planning horizon and are often concerned only with the immediate future.
- Results that show a high degree of convergence are more readily accepted.
- Specialists tend to focus on subsystems rather than the complete system.
- Questionnaire structures typically lead to an oversimplification of the phenomena under study.

Despite the limitations noted above, Delphi inquiry remains the best method available to reach a group consensus.

2.2 Kendall Coefficient of Concordance for Complete Rankings

As stated previously, agreement among the panel members was determined using the Kendall Coefficient of Concordance for Complete Rankings test. The Kendall Coefficient of Concordance test is the technique applicable for "m" sets of rankings on "n" objects. (For example, 3 sets of executives' rankings on 7 predictor variables.) The calculated "W" statistic provides a measure of agreement between treatments. This measure varies between zero and one, where zero indicates no agreement or independent treatment of variable rankings/project scores (perfect randomness) and one indicates perfect agreement (non-randomness). The null hypothesis test criterion is: *there is no agreement among executives.* In hypothesis testing the strength of the test lies with finding significant evidence to reject the null hypothesis. The alternate hypothesis in this case is: *there is agreement among executives.* The calculated "W" is used to enter the Kendall Coefficient of Concordance table and a "P" value is determined. This "P" value is then compared to a previously determined alpha. If the "P" value is less than the alpha then the null hypothesis is rejected and agreement is concluded. The alpha level or critical level is the choice of the decision maker and the analyst. The alpha level is the probability of concluding that the executives agree when, in actuality they do not agree (type I error). Agreement of the executives gives assurance of the model validity. Thus, a low probability of type I error is needed.

The Kendall's Coefficient of Concordance Process can be summarized as follows:

Step 1. State the hypothesis.

Step 2. Sum the rankings for each category.

Step 3. Compute the descriptive measure of agreement W, test statistic.

$$\frac{12 \sum_{j=1}^{n} \left[Rj - (m(n+1))/2 \right]^2}{m^2 n(n^2-1)}$$

Step 4. Derive the critical value from Kendall's Coefficient of Concordance Table.[1] (See APPENDIX A)

Step 5. Determine test criteria.

Step 6. Compare critical value and test statistic.

Step 7. State conclusions.

1. W.W.Daniel, *Applied Nonparametric Statistics* (Boston:Houghton Mifflin Company,1978), pp.470-73.

3.0 PHASE I

The first phase of this project resulted in the establishment of ranges for the seven success predictor variables. It should be noted that the previous contract defined twenty-two variables in seven categories. For the purpose of this study, the seven categories are "variables" and the twenty-two previous variables are used to describe the seven categories.

The first step in Phase I, after the identification of the three executives, was to develop a questionnaire to allow the participants to weight the applicable variables. The questionnaire explained the rules of the Delphi technique, gave some history of the project and defined the seven variables. Some small changes in the definitions of the variables did occur as a result of the opinions obtained from the panel members in the first phase. These changes were incorporated into the second questionnaire to clarify any vagueness in the definitions for the members of the following panel. The first page of this questionnaire explaining the Delphi technique was used in all three phases but will appear only once here. This questionnaire is as follows:

3.1 Delphi Ground Rules

You have been selected to participate in the development of a Project Success Predictor Model. This model's fundamental objective is to provide a mechanism to quantify the success of two or more proposed projects, thus making comparisons simple. You will be asked for your opinion concerning historical projects and factors that influenced the success or failure of each project.

The data acquisition method being used is called the Delphi technique. This method of interrogation was developed by the RAND Corporation during the 1950's. The primary objective of the Delphi technique is to obtain a reliable consensus of a group of experts on uncertain events or events without a historical precedent. The inquiry process is an interactive procedure with controlled feedback but without direct contact among panel members.

Collection of expert opinion by the Delphi technique is an acceptable data gathering technique. However, the validity of the data depends on your cooperation. You are one member of a panel. Please do not discuss your involvement with this process or your opinion concerning the process with anyone. You are allowed to use the reference material that we have provided to assist you in making your judgments. You will be given an

opportunity to review results from each round. In the event a consensus is not reached, you will be asked to revise your opinion based on consideration of the statistics presented.

3.2 Questionnaire # 1 Phase I

This is a part of the developmental process for a Project Success Predictor Model. This is the first phase in a three phase process. The final outcome of the model construction is a set of regression equations, one for manned space activity and the other for unmanned activity. The equations will produce a relative score for the success of each project.

This phase is designed to establish weights for critical success factors. These critical success factors called predictor variables were identified in a previous study. However, no historical data exists to quantify these 7 variables to produce regression equations. The best data available to quantify these variables is expert opinion. Therefore, you are given 100 total points to allocate in any distribution you deem appropriate for a generic project. You can assign all 100 points to one success predictor variable or you can assign the points based on an average (there is no calibration established, assign the values as you see fit). The scores you assign should reflect your opinion on the impact that factor has on the overall success of a project.

The definitions of the predictor variables follow. After reading the definitions please give your values for

each variable on the worksheets provided. There are two identical worksheets provided, one for manned projects and the other for unmanned.

Definitions for Predictor Variables

The seven predictor variables are:

- Financial
- NASA Program Management
- NASA Project Management
- Government/External Environment
- External Public Environment
- Technology
- Public Relations

Definition for Financial Variable

The factors in this category are concerned with the availability of funds at a given time. Without sufficient funding to guarantee success, a program may be reduced in scope, have a significant schedule change, or be eliminated entirely. Risk assessments and budget reserves should be examined and competition from other projects for funds should be considered.

Definition for Program Management Variable

This category examines the priority of the project within the overall structure of NASA organizational objectives. The extent to which the administrators support the project will impact project success. New projects must complement not only other NASA projects and the mission of the organization, but must also complement the people of the organization and the goals they are trying to accomplish.

Definition for Project Management Variable

The NASA project management variable is intended to force a more internal view of the project. Decision makers are allowed to take the "local" stance instead of the broad perspective required when analyzing the program management variable. This variable contains many factors that must be considered from a project's inception. These include the approach, plan, focus, coordination, and clarity of requirements or in other words, the ability to define goals and forecast reasonable schedules in order to complete a project on time. The project manager will have a definite impact on the project's success and his/her past experience must be taken into consideration. The expertise and experience of the technical staff as well as the type of contract and contractor employed are factors influencing project success. Methods of monitoring and reviewing the contract will also impact project success.

Definition for External Government Variable

Projects are at times vulnerable to external forces. This variable represents the impact that the government has on project success. If not identified early in the project, these external forces can impede success. In particular, consumer and environmental laws must be identified as to those which could influence funding. The amount of support from OMB, Congress and the President should be established. The need for interaction with other agencies such as the Air Force or EPA should be considered as this can be beneficial or harmful to a project.

Definition for External Public Environment Variable

NASA must consider the impact a project has on the earth's inhabitants. This category forces the decision maker to examine the project from a public environment perspective. For example, the amount of public support for a project might influence a project's success. The importance of the project to the scientific community and the ease of technological transfer of results is also a consideration.

Definition for Technology Variable

The factors to consider for the technology variable require an unbiased assessment of technology needs and availability to enhance project success. The availability of equipment needed to complete a project should be considered. Existing technology may be adequate for the project but the amount of technical and scientific challenge to use this technology will impact a project's success. Reliability and safety must also be considered as to the likelihood that a project will perform as required and the degree to which human lives will be at stake.

Definition for Public Relations Variables

Public relations in the government arena are quite different than the marketing that is practiced in the commercial sector. This variable will force the decision maker to quantitatively consider the "marketing" of new or ongoing projects. Intrinsic public appeal will win support for a project and the effort required to inform or sway the public or Congress should be examined. The ability of a project to compete with foreign or commercial organizations should also be measured.

MANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	_____
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	_____
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	_____
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	_____
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Transferability of Results	_____
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	_____
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	_____
TOTAL	100

UNMANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	_____
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	_____
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	_____
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	_____
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Transferability of Results	_____
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	_____
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	_____
TOTAL	100

3.3 Phase I Results

As stated in the questionnaire, the executives were given a total of 100 points to distribute among the seven variables. After all three had completed the survey, the variables were ranked for each executive according to the number of points assigned. The variable receiving the most points was given the rank of 1. In case of a tie, the rank consisted of the average of the ranks for the tied variables. For example, if two variables tied for second and third place, each would be given the rank of 2.5 ((2+3)/2). These results were then placed into a spreadsheet designed to calculate agreement/disagreement between the executives. This formula spreadsheet and the results of the Phase I poll and analysis are shown on the following pages.

	A	B	C	D	E	F	G	H	I

Formula Spreadsheet

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM(Rj)	S
FINANCIAL	1.5	1	1.5	1	SUM(B7:E7)	(F7-(32/2))**2
PROGRAM	5	5	4.5	5	SUM(B8:E8)	(F8-(32/2))**2
PROJECT	3	3	3	3	SUM(B9:E9)	(F9-(32/2))**2
EXT. GOVT	4	4	4.5	4	SUM(B10:E10)	(F10-(16))**2
EXT. PUB.	6	6	6.5	6	SUM(B11:E11)	(F11-(16))**2
TECHNOLOG	1.5	2	1.5	2	SUM(B12:E12)	(F12-(16))**2
PUB. REL.	7	7	6.5	7	SUM(B13:E13)	(F13-(16))**2
						SUM(H7:H13)

S = SUM(H7:H13)

$$W = \frac{B15}{(16*7*48)/12} = B18/B20$$

Enter Kendall's Coefficient of Concordance Table with Calculated "W."
Determine "P" value. If "P" < alpha then reject null hypothesis.

Round One Phase One --- Manned

	EXEC 1	EXEC 2	EXEC 3	SUM	S
FINANCIAL	4	1	1.5	6.5	30.25
PROGRAM	4	6	5	15	9
PROJECT	1.5	3.5	1.5	6.5	30.25
EXT. GOVT	4	6	3.5	13.5	2.25
EXT. PUB.	6	6	6	18	36
TECHNOLOG	1.5	2	3.5	7	25
PUB. REL.	7	3.5	7	17.5	30.25
					163

S = 163

$$W = \frac{163}{252} = .6468254$$

At an alpha level of .01 conclude agreement.

Round One Phase One --- Unmanned

	EXEC 1	EXEC 2	EXEC 3	SUM	S
FINANCIAL	4	1	1.5	6.5	30.25
PROGRAM	4	5.5	6	15.5	12.25
PROJECT	1.5	3	1.5	6	36
EXT. GOVT	4	5.5	5	14.5	6.25
EXT. PUB.	6	5.5	3.5	15	9
TECHNOLOG	1.5	2	3.5	7	25
PUB. REL.	7	5.5	7	19.5	56.25
					175

S = 175

$$W = \frac{175}{252} = .6944444$$

At an alpha level of .01 conclude agreement.

The executives were in agreement for both the manned and the unmanned projects. The ranges were then calculated by taking the average score of all three executives for each variable. This number then became the upper range for the variables. The ranges were as follows.

	MANNED	UNMANNED
FINANCIAL	0-23	0-23
PROGRAM	0-11	0-10
PROJECT	0-17	0-18
EXTERNAL GOVERNMENT	0-12	0-11
EXTERNAL PUBLIC	0-08	0-10
TECHNOLOGY	0-22	0-22
PUBLIC RELATIONS	0-07	0-06

Based upon these results it is apparent that the executives felt that the financial, technology, and project management variables have the most impact on project success. These ranges will be used in Phase III.

4.0 PHASE II

In Phase II, four executives were asked to assign a score from zero to two hundred for each of four manned and five unmanned projects. The Phase II questionnaire contained nine fact sheets on these projects. These fact sheets were not intended to be complete histories of the projects described but rather were to be used as a reference. It was stressed to each executive that these sheets were not intended to influence their opinion and that they should base their scores primarily on their own knowledge and expertise concerning each project. One unmanned project, Hubble, was selected using a random drawing process to be used for validating the model. This project was not included when testing for agreement among the executives, although the executives themselves had no knowledge of this fact. The questionnaire and the fact sheets for the projects follow.

4.1 Questionnaire # 1 Phase II

This is a part of the developmental process for a Project Success Predictor Model. The development of the model requires three phases. This is Phase II. The final outcome is a pair of regression equations, one for manned space activity and one for unmanned space activity. The equations will produce a relative score for the success of each project.

This phase is designed to determine "scores" for the success of historical projects. You are asked to provide a value between 0 and 200 for each historical project (where 0 indicates a complete failure and 200 is a perfect project). These scores have never been established before. Therefore, a consensus of expert opinion concerning scores for the success of historical projects is the most reliable method to gather data of this type.

This process requires autonomous participation for valid results. Please do not discuss your involvement in this process nor your opinion on the historical projects being evaluated with anyone. You should feel free to consult the reference material that we have provided to assist you in making your judgments. It should be noted that the reference material is not intended to be a complete history, but rather a noting of some key points to aid in scoring.

The results will be returned to you after each round. If an agreement is not reached you will be asked to re-evaluate your scores in light of the new statistics. A brief overview of the historical projects you are being asked to evaluate follows. After reading the project overviews assign your values for each project.

MANNED PROJECTS

APOLLO

Financial - The estimated cost for the Apollo program was $24 billion in 1969 dollars. Generally speaking, funding was sufficient to accommodate the instabilities associated with development programs. Benefits from the program were numerous and included a better relationship between government and industry, higher reliability and quality control, new management tools, and a new attempt to transfer technology to the non aerospace sector. Adherence to schedule characterized the program more than anything else. There was little competition for funds from other projects until the end of the program when NASA began to realize the need to make room for future programs in the budget.

NASA Program Management - NASA's top management was plagued at times by a feeling they did not have complete technical control over the program. Boeing was brought in as an advisor to spot potential problem areas. President Kennedy's directive for a successful lunar landing gave support to the program.

NASA Project Management - As stated earlier, the Apollo program adhered closely to its schedule. Apollo led to new standardized monthly financial reporting and accounting procedures for NASA and a new low cost audio-visual teleconferencing system was used for reviews of the program between Washington, Houston, Huntsville, and Cape Kennedy.

External Government - President Kennedy gave NASA a deadline for the first lunar landing. NASA worked closely with the Department of Defense and other agencies to ensure that no harmful effects on the human environment would arise from the missions.

External Public - After the fire in 1967 that claimed the lives of three astronauts, public opinion had taken a downswing and many questions were raised as to the merit of the program. In 1979, twelve years after the fire, a survey indicated that public support for the Apollo program had dropped to approximately 49% .

Technology - It is apparent that the technology on the Apollo project had to be developed. Some technology had been developed in earlier projects but for the most part, major technological advances had to be made. Reliability was a major concern because of the presence of humans on the missions. The Apollo project had more than 20,000 failures, mostly minute. However, some of these failures were very serious as in the case of Apollo 1. Safety standards had to be high as human injury was possible.

Public Relations - The space race with the Soviet Union and the concept of landing on the moon had a certain intrinsic appeal to the public. However, with the problems the Apollo project encountered, some effort was required to gain public support. There was a tremendous amount of pressure due to the race with the Soviet Union.

SHUTTLE

Financial - Total cost of the Shuttle program is estimated at $24 billion. After the Challenger accident, $650 million was spent on major changes in the engines, the solid-fuel rockets and other Shuttle components. When the Shuttle program was conceived in 1972, the estimated cost per mission was $10 million. This figure was up to $72 million per mission by 1985.

NASA Program Management - Following the Challenger accident, the entire program management structure was reassessed. Program management philosophy, structure, reporting channels, and decisions were thoroughly reviewed. A new safety program was instituted including an anonymous system for reporting problems. Criticism was voiced over the fact that there was no safety representative involved in the Challenger launch decision.

NASA Project Management - Many changes were made in the way things were done at NASA after Challenger. Most of these changes were in the area of safety. A memo was issued which outlined a strategy for safely returning the Shuttle to flight. This gave NASA Headquarters, particularly the Office of Space Flight, the OSF centers, and the various subcontractors, guidelines under which to proceed.

External Government - There is a great deal of need for interaction with other agencies. Primarily, the Air Force is a major "user" of the Shuttle. In 1985, the many problems such as a three year delay of Columbia, prompted the Air Force to seek rights to build their own rocket to launch critical payloads. This right was granted by the National Security Council in return for a guarantee to use at least one-third of the Shuttle flights. This was necessary to keep the program afloat financially.

External Public - As with Apollo 1, the Challenger accident adversely affected public opinion.

Technology - A great deal of new technology has been developed for the Shuttle program. The Shuttle now has a reusable orbiter, external fuel tank, main engines, and solid rocket booster. The new capability of check-out and repair of satellites in orbit also represents a breakthrough in technology. Many technological changes occurred to the Shuttle program after Challenger. In total, 68 mandatory modifications and 210 optional changes were made by 1988. As stated earlier, the safety program has improved greatly since Challenger.

Public Relations - Foreign competition has played a role in the development of the Shuttle. In particular, French built Ariane rockets were a major competitor which put some pressure on NASA. As stated previously, the Air Force, a major "customer," won the right to manufacture two rockets a year for critical payloads.

SPACE STATION

Financial - The space station program is facing many budget battles because in an era of Gramm-Rudman budget reductions, numerous approved projects are competing for limited funding. The total cost for an initial capability station is targeted at $8 billion. Some benefits to weigh against cost are the creation of jobs, "spin-offs" that will improve the quality of life, and the scientific knowledge gained from experiments conducted in space.

NASA Program Management - This is a NASA headquarters function which addresses such elements as budget allocation interfaces with other agencies such as the Office of Management and Budget, and overall system integration. This project has been envisioned as a natural complement to the Shuttle and a logical step in the space program. The Space Station is planned for initial operation around 1993-94.

NASA Project Management - This is a field center function which includes definition, design, and development of project elements, and launch site, flight, and mission control center operations. Four clearly defined work packages have been designed to divide Space Station elements among various contractors. These contractors include Boeing, Martin Marietta, McDonnell Douglas, and Rocketdyne Division, Rockwell International. All these contractors are experienced which should help establish improved contract monitoring processes.

External Government - In 1984, then President Ronald Reagan directed NASA to develop a permanently manned Space Station within the decade.

External Public - The scientific community, although originally lukewarm to this project, has embraced the station concept and is now participating in the application plans. There has also been a great deal of foreign interest in the Station program. Canada, Europe, and Japan all have worked on the preliminary designs. For example, Canada has worked on manipulator arms and an experimental logistics module. Experience suggests that new space station technology will be transferred to the private sector.

Technology - A great deal of new technology has been needed on this project. In 1985, it was estimated that around $35 million would be needed for technological developments. There is an extensive development program underway to provide technical options that are both reliable and cost effective. Particular areas of interest are automation and robotic technologies.

Public Relations - With the Presidential support this program has received, the general public opinion has been supportive. The Soviet Union has had several versions of a Space station in operation for years and has recently placed into orbit a new space station called Mir.

UNMANNED PROJECTS

Financial - The OMV program has just completed a descoping that will result in a major budget reduction. The new total budget proposal is now under review and should be completed during the second quarter of FY90. Cost overruns, and budget cutbacks have plagued this program since its initiation.

NASA Program Management - Since the OMV will be part of the Space Transportation System, it will fall under the NASA headquarters Office of Space Flight which oversees the Shuttle and its related systems. Level II program management is at MSFC.

NASA Project Management - In 1985, NASA announced that MSFC had issued RFP's to LTV, Martin Marietta, and TRW to compete for a contract to design, develop, and manufacture an orbital maneuvering vehicle. TRW is presently developing the vehicle under a contract with MSFC in Huntsville.

External Government - A GAO audit and congressional scrutiny have had a negative impact on the reputation of this program.

External Public - This program has a very limited amount of public awareness and therefore, little public support. This program could receive a boost if the U.S. is successful in finalizing a working agreement with Canada.

Technology - The OMV's primary use will be to service and retrieve satellites in space. It will be a supplement to the present Space Transport System and will deliver payloads to orbits beyond the practical reach of the Shuttle.

Public Relations - No formal information was discovered at this time as to the public opinion about the OMV.

HUBBLE

Financial - The development cost of the Hubble Space Telescope is approximately $2 billion.

NASA Program Management - The Hubble is a project of many agencies not only in the U.S. but around the world. The NASA Headquarters in Washington is responsible for the overall direction of the program, with MSFC responsible for DDT&E and GSFC responsible for OPS.

NASA Project Management - The MSFC in Huntsville manages the design, development, and construction of the Hubble telescope. However, responsibility was split between MSFC and Goddard Space Flight Center in Maryland and this did cause some communication problems. Two major contractors, Lockheed and Perkin-Elmer, also had a shared responsibility which led to further problems and delays. HST is set for launch in 1990.

External Government - Recommendations for a space telescope began in the early 1960's and two early satellites were launched in 1968 and 1972. It was not until 1977 that Congress authorized funding for the Space Telescope project. Cooperation between a large number of institutions and agencies has been required for this project. The European Space Agency became involved in 1975 and various other groups such as Johns Hopkins University have played key roles in the development of this project.

External Public - Public support data is limited. However, it would appear that the general population is intrigued by the idea of a space telescope.

Technology - Hubble will examine the size and origin of the universe, provide data with which to determine the age and rate of expansion of the universe, and show details of planets and galaxies. These are only a few of the scientific discoveries scientists hope to make and the possibilities are endless. A group of 60 scientists established the basic design for the Hubble. Scientific instruments were furnished by various agencies. Construction was a painstaking process which took almost ten years and was completed in 1985. The Hubble has undergone intensive testing to ensure reliability. The major development challenge was the perfecting of the optics.

Public Relations - There would appear to be no opposition to this project.

HEAO

Financial - In April 1980, it was announced that the HEAO program had been completed essentially on schedule and within budget. The HEAO program consisted of three separate observatories which were to gather data on x-ray, gamma ray, and cosmic ray sources. The first of these was scheduled to be launched in 1975 until a budget cut by Congress forced NASA to halt plans for at least a year. The three observatories were launched in August 1977, November 1978, and September 1979.

NASA Program Management - HEAO was managed for the NASA Office of Space Science by MSFC in Huntsville. The program manager was Richard Halpern.

NASA Project Management - NASA headquarters assigned management responsibilities to MSFC in Huntsville in 1969. MSFC then issued RFP's to 20 firms. Two firms, Grumman Aerospace Corp. and TRW,Inc. were chosen for Phase B contracts. TRW,Inc. eventually received the development contract. At the same time, proposals were accepted for experiments to be conducted aboard the HEAO's.

External Government - In 1969 the president's Space Task Group recommended in its report to President Nixon that high-energy astronomy capability was a high-priority scientific goal.

External Public - The primary purpose of HEAO was to study pulsars, black holes, quasars, and other intriguing mysteries of the universe. Competition may have existed in the sense that satellites during this time were gaining interest in the public sector for such things as broadcasting, medical diagnostics, and disaster relief services.

Technology - As originally conceived, The HEAO's were much larger than any of the previous satellites. Many scientific experiments were designed specifically for HEAO. The budget cut in Congress in 1973 forced a redefinition of HEAO. The large satellites were replaced by much smaller satellites and the agency was forced to drop some of the proposed experiments.

Public Relations - No information was found to indicate public opinion of HEAO.

GALILEO

Financial - This program is the most sophisticated and expensive planetary spacecraft ever. The cost is $1.4 billion which is approximately $1 billion over budget. This is due in part to the redesign of the spacecraft and the redrawing of the trajectory to Jupiter. Galileo will provide information about Venus, Earth, Earth's moon, and finally its primary mission, Jupiter. Jupiter is considered one of the best sources of information about the origins of the universe.

NASA Program Management - The Galileo program was managed by The Office of Space Sciences and Applications (OSSA) in Washington.

NASA Project Management - The launch was originally scheduled for 1982, but numerous setbacks particularly the Challenger accident delayed launch until October of 1989. The MSFC portion of the project was managed by the Space Systems Project Office.

External Government - The major drawback of the Galileo project has been questions concerning the probe power source (48 pounds of radioactive plutonium). Many environmental groups have protested the launch and a lawsuit was filed. However, despite special interest groups' objections, the probe was launched from the shuttle Atlantis in October. This would indicate the amount of support from the President and top management.

External Public - Public opinion was and is very mixed for this project. Many groups have protested against the probe based on their belief that the fuel cell poses an unacceptable risk to Earth's inhabitants. The Galileo must re-enter Earth's orbit twice on its six year mission and if there were to be an accident, plutonium could be released into populated areas, possibly causing cancer, destruction of agricultural products, and land pollution. Prior to launch, there was a great deal of concern about a mishap occurring during the actual launch.

Technology - The early plans for Galileo called for a straight flight to Jupiter. Later, after the Challenger accident postponed the flight, a new series of low-energy launch options were investigated. It was determined that it would be best to use flybys of Earth and Venus to acquire the necessary speed to reach Jupiter. This would also collect the most scientific data. New instruments for collecting data are aboard the Galileo, most of which are modified from previous planetary missions.

Public Relations - As stated previously, this category has presented some difficulty. A great deal of "marketing" was done to convince the public of the need and safety of this project. Numerous statistics have been quoted to assure the public of the small chance of a mishap, however the problem has been to assure the accuracy of these figures.

TETHERED SATELLITE

Financial - The program has had numerous content changes that have driven the initial contract value of $18.9 million to the present EAC of $86.8 million.

NASA Program Management - In 1983, a task group -NASA Tether Applications in Space (TAS) - was formed and is still in existence today. The Tether program is managed by the Office of Space Flight (OSF) in Washington.

NASA Project Management - Level II and III activities are managed at MSFC by the Space Systems Project Office.

External Government - The TAS group consists of members from several NASA centers such as the NASA Headquarters, MSFC, LaRC, and even PSN/CNR of Italy.

External Public - Significant public support or opposition is unlikely due to the limited public awareness of this program and its goals.

Technology - The development of the Tethered Satellite System was started in 1984 and the first flight is planned for 1990. The first flight will prove the capability for collecting scientific data and future flights will include new experiments. Some important considerations are the possibility of a Shuttle becoming entangled with a tether and the added danger involved because of the inability to break away from the satellite. An alternative action in the case of an accident would be to cut the tether. However, this requires the crew of the Shuttle to have enough knowledge to make a decision that will mean the loss of a satellite.

Public Relations - Due to increasing interest in tethers, a working group has been established in Germany. An international conference in 1986 demonstrated the considerable interest in this technology. Public opinion on the tethered satellites is most likely neutral due primarily to lack of information on the subject.

4.2 Phase II Results; Round I

After the executives had completed the survey, the project scores were then ranked and the values entered into the appropriate spreadsheet to test for agreement. These spreadsheets follow.

MANNED

Round One Phase Two

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
APOLLO	1	1	1	1	4	36
STATION	4	4	4	4	16	36
SHUT-PRE	3	2.5	2.5	2.5	10.5	.25
SHUT-POST	2	2.5	2.5	2.5	9.5	.25
						72.5

$S = 72.5$

$$W = \frac{72.5}{80} = .90625$$

At an alpha level of .01 conclude agreement.

UNMANNED

Round One Phase Two

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
HEAO	1	1	1	1	4	36
GALILEO	2	3	3	2	10	0
TETHERED	3.5	3	4	4	14.5	20.25
OMV	3.5	3	2	3	11.5	2.25
						58.5
S=	58.5					

$$W = \frac{58.5}{80} = .73125$$

Computed alpha > .01. Therefore Round 2 required.

The executives were in agreement for the manned projects. However, there was not agreement for the unmanned projects. Therefore an additional questionnaire had to be developed for the second round of Phase II. This questionnaire included a summary of the high, low, and mean value assigned by each executive to the five projects. The questionnaire also provided the high, low, and mean value for each project individually. The executives were then asked to revise their opinion based on these statistics. This questionnaire and the results from round two follow.

4.3 Questionnaire # 2 Phase II

This is the second round in Phase II of the design of a Project Success Predictor Model. A consensus was not reached for the unmanned projects. Please review the statistics provided and revise your project scores in light of the new information.

GENERAL

EXECUTIVE	1	2	3	4
Highest Value Assigned:	185	200	200	175
Lowest Value Assigned:	120	50	75	100
Mean Value Assigned:	155	120	123	115

SPECIFIC

	LOW	HIGH	MEAN
OMV	100	120	105
HUBBLE	100	185	134
HEAO	175	200	188
GALILEO	90	170	128
T. SATELLITE	50	120	86

Thank you again for your assistance and cooperation.

UNMANNED

Round Two Phase Two

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
HEAO	1	1	1	1	4	36
GALILEO	2	2	3	2	9	1
TETHERED	3.5	4	4	4	15.5	30.25
OMV	3.5	3	2	3	11.5	2.25
						69.5

S = 69.5

$$W = \frac{69.5}{80} = .86875$$

At an alpha level of .01 conclude agreement.

4.4 Phase II Results; Round II

On the second iteration, there was agreement at an alpha level of .01. The scores given by each executive will be used in the regression matrix.

5.0 PHASE III

The third phase involved the same four executives that were used in Phase II. In this part of the survey, the executives were asked to assign points for the variables (within the ranges established in Phase I) to the specific projects evaluated in Phase II. The questionnaire for this phase included the definition sheets used in Phase I and the project fact sheets used in Phase II. In addition, the following information sheet was attached.

5.1 Questionnaire # 1 Phase III

This is the final phase of a three phase development process for a Project Success Predictor Model. In this phase you are asked to assign subscores within a specified range to seven success predictor variables for each of nine specific historical projects. The range of each variable and the variables themselves were determined in another independent process. The model, once fully developed, will produce a pair of regression equations, one for manned space activity and another for unmanned activity.

The ranges have different upper limits but each has 0 for the lower limit (where 0 indicates that the variable has no influence on project success). Calibration of predictor variables has never been established before. Therefore, a consensus of expert opinion concerning variable scores is the most reliable method to gather data of this type.

This process requires autonomous participation for valid results. Please do not discuss with anyone your involvement in this process nor your opinion on the predictor variables nor their ranges. However, feel free to consult the reference material provided to assist you in making your judgments.

The results will be returned to you after each round. If an agreement is not reached you will be asked to re-

evaluate your scores in light of the new statistics. A brief overview of the variables you are being asked to evaluate follows.

5.2 Phase III Results

There was agreement for each of the nine projects after the first iteration. The spreadsheet for each project follows.

APOLLO

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM(Rj)	S
FINANCIAL	1.5	1	1.5	1	5	121
PROGRAM	5	5	4.5	5	19.5	12.25
PROJECT	3	3	3	3	12	16
EXT. GOVT	4	4	4.5	4	16.5	.25
EXT. PUB.	6	6	6.5	6	24.5	72.25
TECHNOLOG	1.5	2	1.5	2	7	81
PUB. REL.	7	7	6.5	7	27.5	132.25
						435

S = 435

$$W = \frac{435}{448} = .9709821$$

At an alpha level of .01 conclude agreement.

SPACE STATION

Round One Phase Three

	EXEC 1	EXEC 3	EXEC 3	EXEC 4	SUM	S
FINANCIAL	1.5	3	4	2	10.5	30.25
PROGRAM	4	4	5	4	17	1
PROJECT	3	1	2.5	4	10.5	30.25
EXT. GOVT	5	2	2.5	4	13.5	6.25
EXT. PUB.	6	6.5	6	6	24.5	72.25
TECHNOLOG	1.5	5	1	1	8.5	56.25
PUB. REL.	7	6.5	7	7	27.5	132.25
						328.5

S = 328.5

$$W = \frac{328.5}{448} = .7332589$$

At an alpha level of .01 conclude agreement.

SHUTTLE - PRE CHALLENGER

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
FINANCIAL	3.5	2	2.5	2.5	10.5	30.25
PROGRAM	5	4.5	5.5	4.5	19.5	12.25
PROJECT	2	4.5	2.5	2.5	11.5	20.25
EXT. GOVT	3.5	3	4	4.5	15	1
EXT. PUB.	6	6	5.5	6	23.5	56.25
TECHNOLOG	1	1	1	1	4	144
PUB. REL.	7	7	7	7	28	144
						408

S = 408

$$W = \frac{408}{448} = .9107143$$

At an alpha level of .01 conclude agreement.

SHUTTLE - POST CHALLENGER

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
FINANCIAL	2	1	1	2.5	6.5	90.25
PROGRAM	4.5	4	3	4.5	16	0
PROJECT	1	2	4	2.5	9.5	42.25
EXT. GOVT	3	3	5	4.5	15.5	.25
EXT. PUB.	6	5	6	6	23	49
TECHNOLOG	4.5	6.5	2	1	14	4
PUB. REL.	7	6.5	7	7	27.5	132.25
						318

S = 318

$$W = \frac{318}{448} = .7098214$$

At an alpha level of .01 conclude agreement.

OMV

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
FINANCIAL	2.5	2	5	1	10.5	30.25
PROGRAM	6	6.5	5	4.5	22	36
PROJECT	2.5	3	2	3	10.5	30.25
EXT. GOVT	4	4	3	4.5	15.5	.25
EXT. PUB.	5	5	5	6	21	25
TECHNOLOG	1	1	1	2	5	121
PUB. REL.	7	6.5	7	7	27.5	132.25
						375

S = 375

$$W = \frac{375}{448} = .8370536$$

At an alpha level of .01 conclude agreement.

HUBBLE

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
FINANCIAL	3	1	2	1	7	81
PROGRAM	4.5	6	6	4	20.5	20.25
PROJECT	2	2.5	3	3	10.5	30.25
EXT. GOVT	6	4.5	4.5	5	20	16
EXT. PUB.	4.5	4.5	4.5	6	19.5	12.25
TECHNOLOG	1	2.5	1	2	6.5	90.25
PUB. REL.	7	7	7	7	28	144
						394

S = 394

$$W = \frac{394}{448} = .8794643$$

At an alpha level of .01 conclude agreement.

HEAO

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM	S
FINANCIAL	1	1	2	1	5	121
PROGRAM	4	6	5.5	4	19.5	12.25
PROJECT	3	2.5	3	3	11.5	20.25
EXT. GOVT	5	4.5	4	5	18.5	6.25
EXT. PUB.	6	4.5	5.5	6	22	36
TECHNOLOG	2	2.5	1	2	7.5	72.25
PUB. REL.	7	7	7	7	28	144
						412

S = 412

$$W = \frac{412}{448} = .9196429$$

At an alpha level of .01 conclude agreement.

GALILEO

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC 4	SUM(Rj)	S
FINANCIAL	2	1	6	1	10	36
PROGRAM	4	6	2.5	4	16.5	.25
PROJECT	3	3	2.5	3	11.5	20.25
EXT. GOVT	5	4.5	4.5	5	19	9
EXT. PUB.	6	4.5	4.5	6	21	25
TECHNOLOG	1	2	1	2	6	100
PUB. REL.	7	7	7	7	28	144
						334.5

S = 334.5

$$W = \frac{334.5}{448} = .7466518$$

At an alpha level of .01 conclude agreement.

TETHERED

Round One Phase Three

	EXEC 1	EXEC 2	EXEC 3	EXEC4	SUM	S
FINANCIAL	2	2	5	1	10	36
PROGRAM	4	6	5	4	19	9
PROJECT	3	3	2	3	11	25
EXT. GOVT	5	5	3	5	18	4
EXT. PUB.	6	4	5	6	21	25
TECHNOLOG	1	1	1	2	5	121
PUB. REL.	7	7	7	7	28	144
						364

S = 364

$$W = \frac{364}{448} = .8125$$

At an alpha level of .01 conclude agreement.

6.0 REGRESSION ANALYSIS

The scores obtained for the projects in Phase II are the dependent variables in the regression matrices while the scores assigned to each of the variables for specific projects in Phase III are the independent variables. A regression program was used to calculate the equations, one for manned and one for unmanned projects. The regression matrices are as follows:

MANNED

	Score	Fin	Prog	Proj	EGov	EPub	Tech	PRel
Apollo	190	20	11	16	12	7	20	6
Station	120	12	9	10	8	5	12	4
Pre	130	10	8	14	10	6	16	5
Post	140	12	10	15	11	6	10	4
Apollo	150	23	11	15	12	8	20	7
Station	75	10	8	14	11	3	5	3
Pre	100	12	8	8	10	5	15	4
Post	100	21	8	15	10	7	5	5
Apollo	200	20	11	15	11	7	20	7
Station	50	5	4	6	6	3	20	2
Pre	175	8	5	8	7	5	15	3
Post	125	16	10	8	7	5	15	4
Apollo	200	23	11	17	12	8	22	7
Station	50	10	7	7	7	6	20	4
Pre	175	15	10	15	10	7	20	5
Post	175	13	8	13	8	6	20	4

UNMANNED

	Score	Fin	Prog	Proj	EGov	EPub	Tech	PRel
HEAO	180	19	9	15	8	7	17	4
Galileo	130	17	9	16	8	6	18	4
Tethered	100	12	7	10	6	5	17	3
OMV	100	12	7	10	5	4	14	3
HEAO	175	19	8	15	9	9	15	5
Galileo	150	17	7	13	9	9	15	5
Tethered	100	12	6	10	8	9	15	4
OMV	115	10	4	9	8	6	15	4
HEAO	200	18	9	16	10	9	20	5
Galileo	90	5	9	9	6	6	18	4
Tethered	75	5	5	9	7	5	15	4
OMV	100	5	5	9	7	5	12	4
HEAO	200	23	10	18	9	7	20	3
Galileo	150	23	10	18	9	8	20	4
Tethered	75	23	7	10	5	3	20	1
OMV	100	23	5	15	5	3	20	1

These matrices were entered into a statistical software package and the regression analysis was performed. The results follow.

REGRESSION ANALYSIS OF VARIANCE WITH 7 INDEPENDENT VARIABLES. **MANNED PROJECTS**

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22677.5117	7.0000	3239.6445	1.7636
ABOUT	14695.9248	8.0000	1836.9906	
TOTAL	37373.4380	15.0000		

PR (F > 1.7636) = 0.2218

COEFFICIENTS OF REGRESSION:

B(0) = -20.4236
B(1) = -0.2306
B(2) = 6.3412
B(3) = 9.1102
B(4) = -8.2636
B(5) = 4.5256
B(6) = 3.0541
B(7) = -1.0858

COEFFICIENT OF MULTIPLE CORRELATION = 0.7790
STANDARD ERROR OF THE ESTIMATE = 30.3067

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)
190.0000	20.0000	11.0000	16.0000	12.0000	7.0000	20.0000	6.0000
120.0000	12.0000	9.0000	10.0000	8.0000	5.0000	12.0000	4.0000
130.0000	10.0000	8.0000	14.0000	10.0000	6.0000	16.0000	5.0000
140.0000	12.0000	10.0000	15.0000	11.0000	6.0000	10.0000	4.0000
150.0000	23.0000	11.0000	15.0000	12.0000	8.0000	20.0000	7.0000
75.0000	10.0000	8.0000	14.0000	11.0000	3.0000	5.0000	3.0000
100.0000	12.0000	8.0000	8.0000	10.0000	5.0000	15.0000	4.0000
100.0000	21.0000	8.0000	15.0000	10.0000	7.0000	5.0000	5.0000
200.0000	20.0000	11.0000	15.0000	11.0000	7.0000	20.0000	7.0000
50.0000	5.0000	4.0000	6.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	5.0000	8.0000	7.0000	5.0000	15.0000	3.0000
125.0000	16.0000	10.0000	8.0000	7.0000	5.0000	15.0000	4.0000
200.0000	23.0000	11.0000	17.0000	12.0000	8.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	15.0000	10.0000	15.0000	10.0000	7.0000	20.0000	5.0000
175.0000	13.0000	8.0000	13.0000	8.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.5643	12.4357
120.0000	113.8075	6.1925
130.0000	143.4971	-13.4971
140.0000	139.3260	0.6740
150.0000	171.2022	-21.2022
75.0000	90.2329	-15.2329
100.0000	81.8811	18.1189
100.0000	121.0009	-21.0009
200.0000	175.6320	24.3680
50.0000	81.3555	-31.3555
175.0000	89.6564	85.3436
125.0000	118.4320	6.5680
200.0000	195.5307	4.4693
50.0000	111.4780	-61.4780
175.0000	180.8789	-5.8789
175.0000	163.5247	11.4753

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 7 INDEPENDENT VARIABLES. **UNMANNED PROJECTS**

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	23299.3730	7.0000	3328.4819	6.4936
ABOUT	4100.6265	8.0000	512.5783	
TOTAL	27400.0000	15.0000		

PR (F > 6.4936) = 0.0086

COEFFICIENTS OF REGRESSION:

B(0) =	-25.5619
B(1) =	1.5452
B(2) =	5.8162
B(3) =	3.3225
B(4) =	15.8220
B(5) =	-3.1091
B(6) =	-3.4216
B(7) =	1.3845

COEFFICIENT OF MULTIPLE CORRELATION = 0.9221
STANDARD ERROR OF THE ESTIMATE = 16.0090

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)
180.0000	19.0000	9.0000	15.0000	8.0000	7.0000	17.0000	4.0000
130.0000	17.0000	9.0000	16.0000	8.0000	6.0000	18.0000	4.0000
100.0000	12.0000	7.0000	10.0000	6.0000	5.0000	17.0000	3.0000
100.0000	12.0000	7.0000	10.0000	5.0000	4.0000	14.0000	3.0000
175.0000	19.0000	8.0000	15.0000	9.0000	9.0000	15.0000	5.0000
150.0000	17.0000	7.0000	13.0000	9.0000	9.0000	15.0000	5.0000
100.0000	12.0000	6.0000	10.0000	8.0000	9.0000	15.0000	4.0000
115.0000	10.0000	4.0000	9.0000	8.0000	6.0000	15.0000	4.0000
200.0000	18.0000	9.0000	16.0000	10.0000	9.0000	20.0000	5.0000
90.0000	5.0000	9.0000	9.0000	6.0000	6.0000	18.0000	4.0000
75.0000	5.0000	5.0000	9.0000	7.0000	5.0000	15.0000	4.0000
100.0000	5.0000	5.0000	9.0000	7.0000	5.0000	12.0000	4.0000
200.0000	23.0000	10.0000	18.0000	9.0000	7.0000	20.0000	3.0000
150.0000	23.0000	10.0000	18.0000	9.0000	8.0000	20.0000	4.0000
75.0000	23.0000	7.0000	10.0000	5.0000	3.0000	20.0000	1.0000
100.0000	23.0000	5.0000	15.0000	5.0000	3.0000	20.0000	1.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
180.0000	158.1647	21.8353
130.0000	158.0843	-28.0843
100.0000	92.2928	7.7072
100.0000	89.8446	10.1554
175.0000	170.1799	4.8201
150.0000	154.6282	-4.6282
100.0000	113.9119	-13.9119
115.0000	105.1938	9.8062
200.0000	176.4876	23.5124
90.0000	84.6402	5.3598
75.0000	90.5710	-15.5710
100.0000	100.8357	-0.8357
200.0000	184.3021	15.6979
150.0000	182.5775	-32.5775
75.0000	86.6526	-11.6526
100.0000	91.6328	8.3672

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

Regression Results

The analysis of variance table contains the calculated alpha level at which the model is considered valid. The alpha level for the unmanned projects is .0086 indicating a valid model. However, for the manned projects, the alpha level was .2218 which was determined to be unacceptable. Consequently, further regression analysis was performed using all possible combinations of six variables and all possible combinations of five variables (see APPENDIX C). The alpha level when six variables were used ranged from .12 to .24 while five variables yielded an alpha level ranging from .06 to .17.

The most logical combination of variables for the model was then determined. Since executives in the three phases felt that the public relations variable had the least impact on project success, the regression analysis omitting the public relations variable was selected. This six variable analysis resulted in an alpha level of .12 which is acceptable. The regression analysis for these six variables follows.

REGRESSION ANALYSIS OF VARIANCE WITH 6
INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22675.0703	6.0000	3779.1785	2.3140
ABOUT	14698.3672	9.0000	1633.1519	
TOTAL	37373.4380	15.0000		

PR (F > 2.3140) = 0.1243

COEFFICIENTS OF REGRESSION:

B(0) = -18.3972
B(1) = -0.3350
B(2) = 6.2696
B(3) = 9.1343
B(4) = -8.5006
B(5) = 4.1786
B(6) = 2.9957

COEFFICIENT OF MULTIPLE CORRELATION = 0.7789
STANDARD ERROR OF THE ESTIMATE = 30.3092

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	20.0000	11.0000	16.0000	12.0000	7.0000	20.0000
120.0000	12.0000	9.0000	10.0000	8.0000	5.0000	12.0000
130.0000	10.0000	8.0000	14.0000	10.0000	6.0000	16.0000
140.0000	12.0000	10.0000	15.0000	11.0000	6.0000	10.0000
150.0000	23.0000	11.0000	15.0000	12.0000	8.0000	20.0000
75.0000	10.0000	8.0000	14.0000	11.0000	3.0000	5.0000
100.0000	12.0000	8.0000	8.0000	10.0000	5.0000	15.0000
100.0000	21.0000	8.0000	15.0000	10.0000	7.0000	5.0000
200.0000	20.0000	11.0000	15.0000	11.0000	7.0000	20.0000
50.0000	5.0000	4.0000	6.0000	6.0000	3.0000	20.0000
175.0000	8.0000	5.0000	8.0000	7.0000	5.0000	15.0000
125.0000	16.0000	10.0000	8.0000	7.0000	5.0000	15.0000
200.0000	23.0000	11.0000	17.0000	12.0000	8.0000	22.0000
50.0000	10.0000	7.0000	7.0000	7.0000	6.0000	20.0000
175.0000	15.0000	10.0000	15.0000	10.0000	7.0000	20.0000
175.0000	13.0000	8.0000	13.0000	8.0000	6.0000	20.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.1748	12.8252
120.0000	114.1892	5.8108
130.0000	144.2871	-14.2871
140.0000	138.8159	1.1841
150.0000	171.2141	-21.2141
75.0000	90.2980	-15.2980
100.0000	81.6369	18.3631
100.0000	120.9625	-20.9625
200.0000	176.5411	23.4589
50.0000	81.2583	-31.2583
175.0000	89.6698	85.3302
125.0000	118.3379	6.6621
200.0000	195.4742	4.5258
50.0000	111.5618	-61.5618
175.0000	180.4470	-5.4470
175.0000	163.1317	11.8683

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

Another useful criterion in regression analysis is the coefficient of multiple correlation. This number is expressed as a percentage. A large number is desirable, indicating that the equation explains the variation in the data. These correlation coefficients were calculated at approximately .90 for the unmanned (using seven variables) and .80 for the manned equations (omitting the public relations variable).

Based on these results, it is recommended that the model be used with the seven predictor variables for the unmanned equation and six predictor variables (excluding public relations) for the manned equation. The final models for manned and unmanned projects are as follows:

UNMANNED

$$Y= -25.5691+1.5452(X1)+5.8162(X2)+3.3225(X3)+15.8220(X4)-3.1091(X5)-3.4216(X6)+1.3845(X7)$$

MANNED

$$Y= -18.3972-.3350(X1)+6.2696(X2)+9.1343(X3)-8.5006(X4)+4.1786(X5)+2.9957(X6)$$

The variable ranges were changed for the manned projects to reflect the exclusion of the public relations variable. These new ranges are as follows:

VARIABLE	OLD RANGE	NEW RANGE
Financial	0-23	0-25
Program Management	0-11	0-12
Project Management	0-17	0-18
External Government	0-12	0-13
External Public	0-8	0-9
Technology	0-22	0-23
Public Relations	0-7	XXXX

The seven points for the public relations variable were distributed among the other variables such that the financial variable received two points and the other five received one point each.

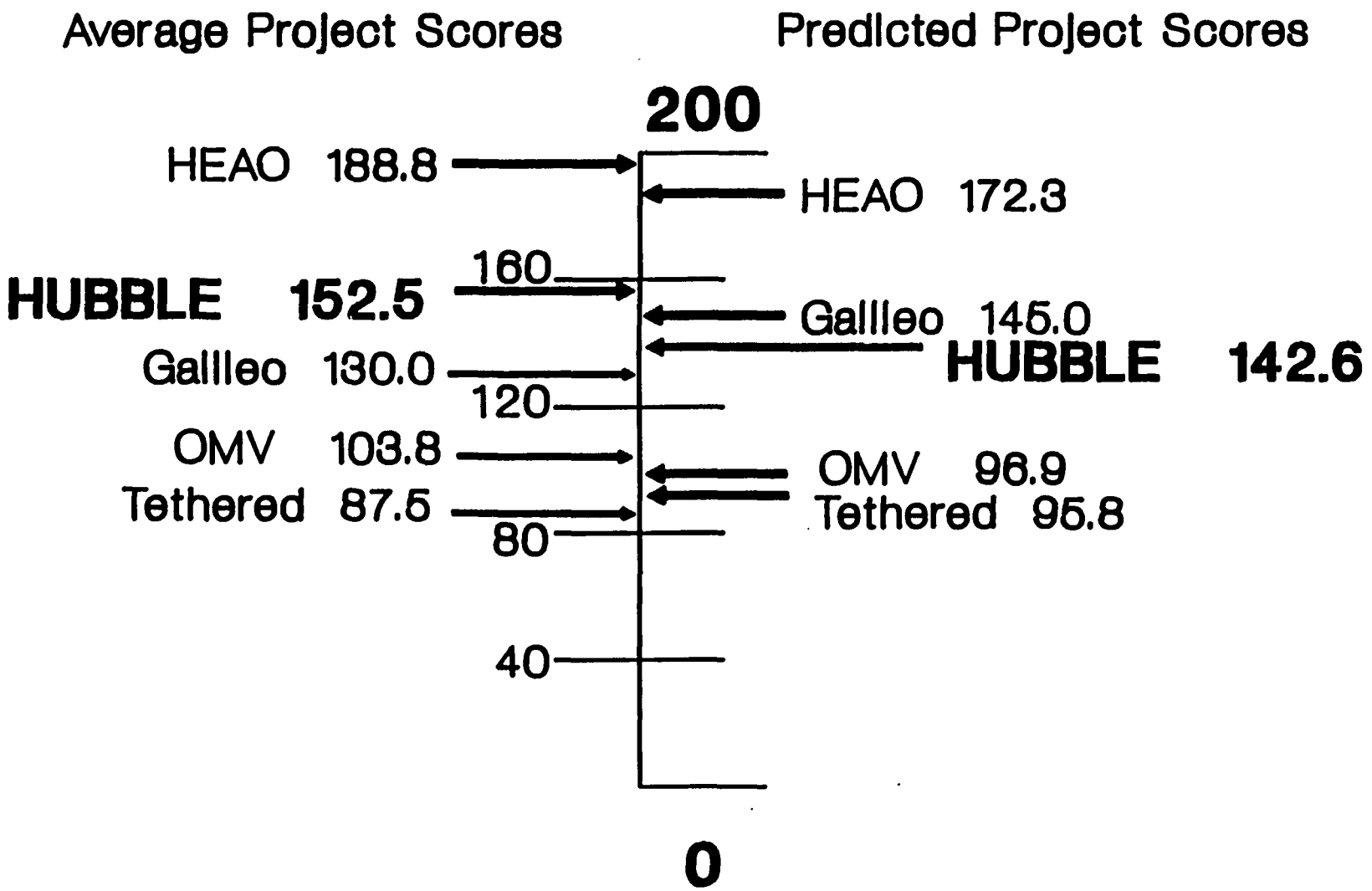
7.0 VALIDATION

Validation of the models was accomplished by averaging the four executives' scores for each of the seven variables in Phase III. These results (found in APPENDIX B) were then entered into the model and a predicted score was obtained. The average of the scores from Phase II was then compared to these predicted scores and the differences (residuals) were calculated. The predicted scores and the actual averaged scores are shown in the subsequent charts.

RESULTS

	Avg. Score	P(agreement exists)	Predicted (based on avg. of variables)		Residuals
MANNED					
Apollo	185.0	.995	180.1		4.9
Sp.Station	73.8	.872	99.3		-25.5
Pre	132.5	.977	124.0		8.5
Post	135.0	.872	135.3		- .3
				SUM	-12.4
UNMANNED					
OMV	103.8	.980	96.9		6.9
HEAO	188.8	.994	172.3		16.5
Galileo	130.0	.966	145.0		-15.0
Tethered	87.5	.946	95.8		-8.3
				SUM	.1
VALIDATION					
Hubble	152.5	.992	142.6		

VALIDATION


Average Project Scores
Predicted Project Scores
200
HEAO 188.8
HEAO 172.3
160
HUBBLE 152.5
Galileo 145.0
Galileo 130.0
HUBBLE 142.6
120
OMV 103.8
OMV 96.9
Tethered 87.5
Tethered 95.8
80
40
0

8.0 Conclusion

This report presents in detail the development of a Project Success Predictor Model. NASA executives were interviewed to obtain subjective opinions regarding the impact of seven predictor variables on project success. The Delphi Method for data collection and the Kendall Coefficient of Concordance for Complete Rankings test were used during this process. The results were then incorporated into two equations by regression analysis. These equations were coded into the predictor model and, during model use, serve to calculate a score for quantitative project comparison. These scores can then be used by top management as a decision tool for the budgetary and systems engineering lifecycles.

APPENDIX A

PROGRAM DOCUMENTATION

This program is written in interpreter basic (GWBASIC) and should run on any IBM compatible machine. A printer must be connected and turned on prior to running the second option of the program. The program disk should be in drive "A." The program is menu driven. The options provided in the main menu include:

1. Load predictor variable file from disk
2. View predictor variable file
3. Input new predictor variable file
4. Input new predictor model equations
5. Calculate prediction of project success
6. Change current predictor variable file
7. Stop program execution

To initiate an analysis, Option 1 may be chosen if a predictor variable file has already been entered and saved to disk. A predictor variable file is a data file which contains the individual scores assigned by the participating executives to the individual variables. If no predictor variable file has been created, then Option 3 must be chosen. Upon choosing Option 3, the user is queried for the number of executives and whether the project is manned or unmanned. Once the program user has supplied this information, the program continues by querying for the score assigned by each executive to the individual variables. After all scores have been entered, the program calculates and displays the W-Statistic associated with the probability that the executives

were not in agreement. Next, the program queries the user for the file name. The prefix "A:" should not be included since the program automatically adds this to the file name.

Once a predictor variable file has been created and saved to disk, Option 2, View predictor variable file, may be chosen. Two options of viewing the file are provided, screen and printed. If "printed" is chosen, the printer must be on line. In addition to the program being discussed, NASA.BAS, predictor variable data files are also provided on the disk. These predictor variable data files were collected during the process of developing this model. The predictor variable files included are:

Manned - Apollo (APOLLO)
Space Station (SPASTAT)
Pre Challenger (PRECHAL)
Post Challenger (POSTCHAL)

Unmanned - HEAO (HEAO)
Hubble (HUBBLE)
OMV (OMV)
Tethered Satellite (TETHERED)
Galileo (GALILEO)

These files may be selected for viewing as discussed above (Option 2) or they may be changed by choosing Option 6. This option begins by displaying the current predictor variable data file. Depressing the ENTER key results in a query from the program above for the number of the variable "(1-7)" for un-

manned projects and "(1-6)" for manned projects. Next, the user is queried for the number of the executive whose predictor variable is to be changed and the new weight to be assigned to the variable. The new current predictor variable file is now displayed on the screen. At this point in program execution, the program again displays the W-Statistic associated with the probability of the executives not being in agreement. The user now has the option of choosing 1. MORE CHANGES or 2. RETURN TO MAIN MENU. The change subroutine above is repeated if the MORE CHANGES choice is made. If RETURN TO MAIN MENU is chosen, then a file name must be supplied. This file name may be either a new name or the old file name. If the old file name is used, then the old file will be replaced by the one which has been changed. If a new file name is used, then a new file will be created and the old file will still exist on disk.

In addition to the historical project files (APOLLO, SPASTAT, PRECHAL, POSTCHAL, HEAO, HUBBLE, OMV, TETHERED, and GALILEO), another file is resident on the disk which is provided as a deliverable under this contract. This file is named EQUATN and is automatically loaded each time Option 5 (Calculate prediction of project success) is exercised. The EQUATN file contains the coefficients for both the manned and unmanned predictor equations. These equations can be updated by choosing Option 4, Input new predictor model equations. After choosing MANNED or UNMANNED, the current coefficients will be displayed and the program user will have the opportunity to change any, all, or none of the

individual coefficients. The updated file will automatically be saved to disk.

The actual calculation of project success is achieved with Option 5. First, the contents of the predictor variable file are presented on the screen. Next, the project success score is presented, after which the user is returned to the main menu.

There are two situations in the running of the program where a message will be encountered which first presents the value of Kendall's Coefficient of Concordance Statistic, W = .## and then refers the user to Table A.22 of a book on nonparametric statistics. This reference only needs to be used if detailed analyses (such as those used to develop the model) are being carried out.

The last option in the main menu is Option 7, Stop program execution, which is self explanatory. The program automatically saves data files if the user always responds with a program name when queried, even if the query seems redundant.

In summary, the program is intended to be user friendly. Hopefully, all options in the program are self explanatory. The program is not designed to include fail safe mechanisms. An unwary user can "blow-up" a run of the program, but it should be very difficult to damage the data files or the program itself. As an aid to deeper understanding of the program, a list of variable definitions and a program listing follow.

VARIABLES

NV - The number of predictor variables in a predictor file. The value is either six for manned projects or seven for unmanned projects.

NOB - The number of observers/experts whose opinions are the basis for a predictor variable data set.

W - Kendall's coefficient of concordance test statistic.

RAW(j,k) - Executive k's estimate of variable j's importance to the respective project's success.

KEN(j,k) - Executive k's ranking of variable j's relative importance to the other variables for a given project.

SORT(j,k) - A temporary variable used to translate RAW data to KENdall based data.

W$(j,k) - A string variable giving the title and range for variable j, with k=1=Manned and k=2=Unmanned.

Table A.22 Kendall's coefficient of concordance

m = 3

n = 2	
W	*P*
.000	1.000
.250	.833
.750	.500
1.000	.167

n = 3	
W	*P*
.000	1.000
.111	.944
.333	.528
.444	.361
.778	.194
1.000	.028

n = 4	
W	*P*
.000	1.000
.062	.931
.188	.653
.250	.431
.438	.273
.562	.125
.750	.069
.812	.042
1.000	.005

n = 5	
W	*P*
.000	1.000
.040	.954
.120	.691
.160	.522
.280	.367
.360	.182
.480	.124
.520	.093
.640	.039
.760	.024
.840	.008
1.000	.001

n = 6	
W	*P*
.000	1.000
.028	.956
.083	.740
.111	.570
.194	.430
.250	.252
.333	.184
.361	.142
.444	.072
.528	.052
.583	.029
.694	.012
.750	.008
.778	.006
.861	.002
1.000	.000

n = 7	
W	*P*
.000	1.000
.020	.964
.061	.768
.082	.620
.143	.486
.184	.305
.245	.237
.265	.192
.326	.112
.388	.085
.429	.051
.510	.027
.551	.021
.571	.016
.633	.008
.735	.004
.755	.003
.796	.001
.878	.000
1.000	.000

n = 8	
W	*P*
.000	1.000
.016	.967
.047	.794
.062	.654
.109	.531
.141	.355
.188	.285
.203	.236
.250	.149
.297	.120
.328	.079
.391	.047
.422	.038
.438	.030
.484	.018
.562	.010
.578	.008
.609	.005
.672	.002
.750	.001
.766	.001
.812	.000
.891	.000
1.000	.000

n = 9	
W	*P*
.000	1.000
.012	.971
.037	.814
.049	.685
.086	.569
.111	.398
.148	.328
.160	.278
.198	.187
.235	.154
.259	.107
.309	.069
.333	.057
.346	.048
.383	.031
.444	.019
.457	.016
.482	.010
.531	.006
.593	.004
.605	.003
.642	.001
.704	.001
.753	.000
1.000	.000

n = 10	
W	*P*
.000	1.000
.010	.974
.030	.830
.040	.710
.070	.601
.090	.436
.120	.368
.130	.316
.160	.222
.190	.187
.210	.135
.250	.092
.270	.078
.280	.066
.310	.046
.360	.030
.370	.026
.390	.018
.430	.012
.480	.007
.490	.006
.520	.003
.570	.002
.610	.001
.630	.001
.640	.001
.670	.000
1.000	.000

n = 11	
W	*P*
.000	1.000
.008	.976
.025	.844
.033	.732
.058	.629
.074	.470
.099	.403
.107	.351
.132	.256
.157	.219
.174	.163
.207	.116
.223	.100
.231	.087
.256	.062
.298	.043
.306	.037
.322	.027
.355	.019
.397	.013
.405	.011
.430	.007
.471	.005
.504	.003
.521	.002
.529	.002
.554	.001
.603	.001
.620	.000
1.000	.000

n = 12	
W	*P*
.000	1.000
.007	.978
.021	.856
.028	.751
.049	.654
.062	.500
.083	.434
.090	.383
.111	.287
.132	.249
.146	.191
.174	.141
.188	.123
.194	.108
.215	.080
.250	.058
.257	.050
.271	.038
.299	.028
.333	.019
.340	.017
.361	.011
.396	.008
.424	.005
.438	.004
.444	.004
.465	.002

Source: Donald B. Owen, *Handbook of Statistical Tables*, Reading, Mass: Addison-Wesley, 1962, and Maurice G. Kendall, *Rank Correlation Methods*, fourth edition, Charles Griffin & Company, Ltd, High Wycombe, Bucks., England; reprinted by permission

Note: *P* = the probability of a computed value of *W* greater than or equal to the tabulated value.

m = 3

n = 12 (cont.)	
W	*P*
.507	.002
.521	.001
.528	.001
.549	.001
.562	.001
.583	.000
.	.
.	.
.	.
1.000	.000

n = 13	
W	*P*
.000	1.000
.006	.980
.018	.866
.024	.767
.041	.657
.053	.527
.071	.463
.077	.412
.095	.316
.112	.278
.124	.217
.148	.165
.160	.145
.166	.129
.183	.098
.213	.073
.219	.064
.231	.050
.254	.038
.284	.027
.290	.025
.308	.016
.337	.012
.361	.008
.373	.007
.379	.006
.396	.004
.432	.003
.444	.002
.450	.002
.467	.001
.479	.001
.497	.001
.538	.001
.550	.000
.	.
.	.
.	.
1.000	.000

n = 14	
W	*P*
.000	1.000
.005	.981
.015	.874
.020	.781
.036	.694
.046	.551
.061	.489
.066	.438
.082	.344
.097	.305
.107	.242
.128	.188
.138	.167
.143	.150
.158	.117
.184	.089
.189	.079
.199	.063
.219	.049
.245	.036
.250	.033
.265	.023
.291	.018
.311	.011
.321	.010
.327	.009
.342	.007
.372	.005
.383	.003
.388	.003
.403	.003
.413	.002
.429	.002
.464	.001
.474	.001
.495	.000
.	.
.	.
1.000	.000

n = 15	
W	*P*
.000	1.000
.004	.982
.013	.882
.018	.794
.031	.711
.040	.573
.053	.513
.058	.463
.071	.369
.084	.330
.093	.267
.111	.211
.120	.189
.124	.170
.138	.136
.160	.106
.164	.096
.173	.077
.191	.059
.213	.047
.218	.043
.231	.030
.253	.022
.271	.018
.280	.015
.284	.011
.298	.010
.324	.007
.333	.005
.338	.005
.351	.004
.360	.004
.373	.003
.404	.002
.413	.001
.431	.001
.444	.001
.458	.001
.480	.000
.	.
.	.
1.000	.000

(continued on page 472)

$m = 4$

$n = 2$

W	P
.000	1.000
.100	.958
.200	.833
.300	.792
.400	.625
.500	.542
.600	.458
.700	.375
.800	.208
.900	.167
1.000	.042

$n = 3$

W	P
.022	1.000
.067	.958
.111	.910
.200	.727
.244	.615
.289	.524
.378	.446
.422	.328
.467	.293
.556	.207
.600	.182
.644	.161
.733	.075
.778	.054
.822	.026
.911	.017
1.000	.002

$n = 4$

W	P
.000	1.000
.025	.992
.050	.930
.075	.898
.100	.794
.125	.753
.150	.680
.175	.651
.200	.528
.225	.513
.250	.432
.275	.390
.300	.352
.325	.321
.375	.237
.400	.199
.425	.188
.450	.159
.475	.141
.500	.106
.525	.093
.550	.077
.575	.069
.600	.058
.625	.054
.650	.036

$n = 4$ (cont.)

W	P
.675	.035
.700	.020
.725	.013
.775	.011
.800	.006
.825	.005
.850	.002
.900	.002
.925	.001
1.000	.000

$n = 5$

W	P
.008	1.000
.024	.974
.040	.944
.072	.857
.088	.769
.104	.710
.136	.652
.152	.563
.168	.520
.200	.443
.216	.406
.232	.368
.264	.301
.280	.266
.296	.232
.328	.213
.344	.162
.360	.151
.392	.119
.408	.102
.424	.089
.456	.071
.472	.067
.488	.057
.520	.049
.536	.033
.552	.032
.584	.024
.600	.021
.616	.015
.648	.011
.664	.009
.680	.008
.712	.006
.728	.003
.744	.002
.776	.002
.792	.001
.808	.001
.840	.000
1.000	.000

$n = 6$

W	P
.000	1.000
.011	.996
.022	.952
.033	.938
.044	.878
.056	.843
.067	.797
.078	.779
.089	.676
.100	.666
.111	.608
.122	.566
.133	.541
.144	.517
.167	.427
.178	.385
.189	.374
.200	.337
.211	.321
.222	.274
.233	.259
.244	.232
.256	.221
.267	.193
.278	.190
.289	.162
.300	.154
.311	.127
.322	.113
.344	.109
.356	.088
.367	.087
.378	.073
.389	.067
.400	.063
.411	.058
.422	.043
.433	.041
.444	.036
.456	.033
.467	.031
.478	.027
.489	.021
.500	.021
.522	.017
.533	.015
.544	.015
.556	.011
.567	.010
.578	.009
.589	.008
.600	.006
.611	.006
.633	.004
.644	.003
.656	.003
.667	.002
.678	.002
.700	.001
.711	.001

$n = 6$ (cont.)

W	P
.722	.001
.733	.001
.744	.001
.756	.000
.	.
.	.
.	.
1.000	.000

$n = 7$

W	P
.004	1.000
.012	.984
.020	.964
.037	.905
.045	.846
.053	.795
.069	.754
.078	.678
.086	.652
.102	.596
.110	.564
.118	.533
.135	.460
.143	.420
.151	.378
.167	.358
.176	.306
.184	.300
.200	.264
.208	.239
.216	.216
.233	.188
.241	.182
.249	.163
.265	.150
.273	.122
.282	.118
.298	.101
.306	.093
.314	.081
.331	.073
.339	.062
.347	.058
.363	.051
.371	.040
.380	.037
.396	.034
.404	.032
.412	.030
.429	.024
.437	.021
.445	.018
.461	.016
.469	.014
.478	.013
.494	.009
.502	.008
.510	.008
.527	.007
.535	.006

$n = 7$ (cont.)

W	P
.543	.004
.559	.004
.567	.003
.576	.003
.592	.003
.600	.002
.608	.002
.624	.001
.633	.001
.641	.001
.657	.001
.665	.001
.673	.001
.690	.000
.	.
.	.
.	.
1.000	.000

$n = 8$

W	P
.000	1.000
.006	.998
.012	.967
.019	.957
.025	.914
.031	.890
.038	.853
.044	.842
.050	.764
.056	.754
.062	.709
.069	.677
.075	.660
.081	.637
.094	.557
.100	.509
.106	.500
.112	.471
.119	.453
.125	.404
.131	.390
.137	.364
.144	.348
.156	.325
.162	.297
.169	.283
.175	.247
.181	.231
.194	.217
.200	.185
.206	.182
.212	.162
.219	.155
.225	.153
.231	.144
.238	.122
.244	.120
.250	.112
.256	.106

$m = 4$

$n = 8$ (cont.)

W	P
.262	.098
.269	.091
.281	.077
.294	.067
.300	.062
.306	.061
.312	.052
.319	.049
.325	.046
.331	.043
.338	.038
.344	.037
.356	.031
.362	.028
.369	.026
.375	.023
.381	.021
.394	.019
.400	.015
.406	.015
.412	.013
.419	.013
.425	.011
.431	.010
.438	.009
.444	.008
.450	.008

$n = 8$ (cont.)

W	P
.456	.008
.462	.007
.469	.007
.475	.006
.481	.005
.494	.004
.500	.004
.506	.004
.512	.003
.519	.003
.525	.002
.531	.002
.538	.002
.544	.002
.550	.002
.556	.002
.562	.001
.569	.001
.575	.001
.581	.001
.594	.001
.606	.001
.612	.000
.	.
.	.
.	.
1.000	.000

$m = 5$

$n = 3$

W	P
.000	1.000
.022	1.000
.044	.988
.067	.972
.089	.941
.111	.914
.133	.845
.156	.831
.178	.768
.200	.720
.222	.682
.244	.649
.267	.595
.289	.559
.311	.493

$n = 3$ (cont.)

W	P
.333	.475
.356	.432
.378	.406
.400	.347
.422	.326
.444	.291
.467	.253
.489	.236
.511	.213
.533	.172
.556	.163
.578	.127
.600	.117
.622	.096
.644	.080

$n = 3$ (cont.)

W	P
.667	.063
.689	.056
.711	.045
.733	.038
.756	.028
.778	.026
.800	.017
.822	.015
.844	.008
.867	.005
.889	.004
.911	.003
.956	.001
1.000	.000

PROGRAM LISTING

```
10 '.....................................................................
20 '.....................................................................
30 '....                                                               ...
40 '....                                                               ...
50 '....          NASA PROJECT PREDICTOR SUCCESS MODEL                 ...
60 '....                                                               ...
70 '....             DEVELOPED AT THE UNIVERSITY OF                    ...
80 '....                                                               ...
90 '....                 ALABAMA IN HUNTSVILLE                         ...
100 '...                                                               ...
110 '...             CONTRACT No. NAS8-36955/D.O.68                    ...
120 '...                                                               ...
130 '.....................................................................
140 '.....................................................................
150 COLOR 14,13,1
160 KEY OFF
170 DIM RAW(10,10),KEN(10,10),SORT(10,10),W$(7,2)
180 GOSUB 2680
190 CLS : PRINT : PRINT TAB(10)"NASA MARSHALL SPACE FLIGHT CENTER -
PROJECT SUCCESS PREDICTOR MODEL"
200 PRINT
210 PRINT TAB(15)"1.  LOAD PREDICTOR VARIABLE FILE FROM DISK"
220 PRINT TAB(15)"2.  VIEW PREDICTOR VARIABLE FILE "
230 PRINT TAB(15)"3.  INPUT NEW PREDICTOR VARIABLE FILE"
240 PRINT TAB(15)"4.  INPUT NEW PREDICTOR MODEL EQUATIONS"
250 PRINT TAB(15)"5.   CALCULATE PREDICTION OF PROJECT SUCCESS":
PRINT TAB(19)"(FILE MUST HAVE BEEN INPUT WITH 3. ABOVE)"
260 PRINT TAB(15)"6.  CHANGE CURRENT PREDICTOR VARIABLE FILE"
270 PRINT TAB(15)"7.  STOP PROGRAM EXECUTION"
280 PRINT
290 GOSUB 1230
300 IF IC=7 THEN KEY ON
310 IF IC=7 THEN CLS
320 IF IC=7 THEN END
330 CLS
340 ON IC GOSUB 360,2860,650,1620,910,3420
350 GOTO 190
360 '
370 '.....................  LOAD FILE FROM DISK
380 '
390 GOSUB 1500
400 PRINT : INPUT"PREDICTOR SET FILE NAME";FILE$
410 NAM$="A:"+FILE$
420 OPEN "I",#1,NAM$
430 INPUT #1,NV,NOB
440 FOR J=1 TO NV
450  FOR K=1 TO NOB
460     INPUT #1,RAW(J,K)
470  NEXT K
480 NEXT J
```

```
490 CLOSE
500 RETURN
510 '
520 '.....  SAVE FILE TO DISK
530 '
540 PRINT : INPUT"PREDICTOR SET FILE NAME";FILE$
550 NAM$="A:"+FILE$
560 OPEN "O",#1,NAM$
570 PRINT #1,NV,NOB
580 FOR J=1 TO NV
590   FOR K=1 TO NOB
600     PRINT #1,RAW(J,K)
610   NEXT K
620 NEXT J
630 CLOSE
640 RETURN
650 '
660 '..... INPUT (EXECUTIVES) NEW PREDICTOR VARIABLE
FILE
670 '
680 GOSUB 1500
690 INPUT"NUMBER OF EXECUTIVES";NOB
700 PRINT
710 PRINT
720 PRINT"1. MANNED
730 PRINT
740 PRINT"2. UNMANNED"
750 PRINT
760 GOSUB 1240
770 IF IC=1 THEN NV=6 ELSE NV=7
780 FOR EXEC = 1 TO NOB
790 CLS
800 PRINT"EXECUTIVE NUMBER ";EXEC : PRINT
810   FOR J=1 TO NV
820     PRINT W$(J,NV-5);" SCORE";
830     INPUT RAW(J,EXEC)
840   NEXT J
850 NEXT EXEC
860  GOSUB 2970
870  GOSUB 1970
880  GOSUB 2460
890 GOSUB 510
900 RETURN
910 '
920 '..... CALCULATION OF PROJECT SUCCESS PREDICTOR
SCORE
930 '
940 GOSUB 1500
950 INPUT"PREDICTOR SET FILE NAME";FILE$
960 GOSUB 410
970 GOSUB 2970
980 GOSUB 1970
990 EFILE$="A:EQUATN"
1000  OPEN "I",#1,EFILE$
1010  FOR J=0 TO 7
```

```
1020   FOR K=1 TO 2
1030     INPUT #1,COEF(J,K)
1040   NEXT K
1050  NEXT J
1060  CLOSE
1070  FOR J=0 TO NV
1080   SUM=0
1090   FOR K=1 TO NOB
1100    SUM=SUM+RAW(J,K)
1110   NEXT K
1120  P(J)=SUM/NOB
1130 IF J=0 THEN P(J)=1
1140  NEXT J
1150 SUM=0
1160 FOR J=0 TO NV
1170   SCOR(J)=P(J)*COEF(J,NV-5)
1180   SUM=SUM+SCOR(J)
1190 NEXT J
1200 PRINT"PROJECT SUCCESS SCORE = ";SUM
1210 PRINT: PRINT"READY/ENTER"    :  GOSUB 1230
1220 RETURN
1230 '
1240 '.......   INPUT VALUES - HOT MENU
1250 '
1260 RESPONSE$=""
1270 COLOR 27,4,1
1280       PRINT"                                                    RESPONSE
";
1290 A$=INKEY$
1300 RESPONSE$=RESPONSE$+A$
1310 IF RESPONSE$="" THEN GOTO 1290
1320 IC=VAL(RESPONSE$)
1330 ANS$=RESPONSE$
1340 SCREEN 0
1350 COLOR 14,13,1
1360 RETURN
1370 '
1380 '.......   INPUT VALUES - COLD MENU
1390 '
1400 RESPONSE$=""
1410 COLOR 27,4,1
1420 A$=INKEY$
1430 RESPONSE$=RESPONSE$+A$
1440 IF RESPONSE$="" THEN GOTO 1420
1450 IC=VAL(RESPONSE$)
1460 ANS$=RESPONSE$
1470 PRINT A$
1480 COLOR 14,13,1
1490 RETURN
1500 '
1510 '.................  ERASE  FILES  RAW,  KEN,  P
1520 '
1530 FOR J=1 TO 10
1540   P(J)=0
1550   FOR K=1 TO 10
```

```
1560      RAW(J,K)=0
1570      KEN(J,K)=0
1580    NEXT K
1590  NEXT J
1600  FILE$="" : NAM$=""
1610  RETURN
1620  '
1630  '.............. INPUT NEW PREDICTOR EQUATIONS
1640  '
1650  PRINT TAB(10)"EQUATION UPDATE:"
1660  PRINT
1670  PRINT TAB(15)"1.   MANNED"
1680  PRINT
1690  PRINT TAB(15)"2.   UNMANNED"
1700  PRINT
1710  GOSUB 1230
1720  EFILE$="A:EQUATN"
1730  OPEN "I",#1,EFILE$
1740  FOR J=0 TO 7
1750   FOR K=1 TO 2
1760     INPUT #1,COEF(J,K)
1770   NEXT K
1780  NEXT J
1790  CLOSE
1800  IF IC=1 THEN NV=6 ELSE NV=7
1810  FOR J=0 TO NV
1820    PRINT W$(J,NV-5);"  COEFFICIENT = ";COEF(J,NV-5)
1830    PRINT
1840       INPUT"NEW  VALUE  FOR  THE  COEFFICIENT  **ENTER**  =  NO
CHANGE";VALUE
1850  IF VALUE<>0 THEN COEF(J,NV-5)=VALUE
1860  VALUE=0
1870  CLS
1880  NEXT J
1890  OPEN "O",#1,EFILE$
1900  FOR J=0 TO 7
1910   FOR K=1 TO 2
1920     PRINT #1,COEF(J,K)
1930   NEXT K
1940  NEXT J
1950  CLOSE
1960  RETURN
1970  '
1980  '..................... RANKS FROM RAW SCORES
1990  '
2000  '..................... INPUTS = NV,  NOB,  RAW(NV,NOB)
2010  '
2020  '..................... OUTPUT = KEN(NV,NOB)
2030  '
2040  FOR EXEC = 1 TO NOB
2050    MAX=300
2060    FOR J=1 TO NV
2070      SORT(J,1)=RAW(J,EXEC)
2080    NEXT J
2090    FOR COUNT=1 TO NV
```

```
2100 MAX=0
2110     FOR J=1 TO NV
2120       IF SORT(J,2)=0 AND SORT(J,1))MAX THEN MAX=SORT(J,1)
2130     NEXT J
2140     FOR J=1 TO NV
2150       IF SORT(J,1)=MAX  AND SORT(J,2)=0 THEN SORT(J,2)=COUNT
2160     NEXT J
2170  NEXT COUNT
2180 NREP=0 : SUM=0 : BEGIN=1
2190 MIN=2*NV
2200 FOR J=1 TO NV
2210   IF SORT(J,2)(=MIN AND SORT(J,2))0 THEN MIN=SORT(J,2)
2220 NEXT J
2230 FOR J=1 TO NV
2240   IF SORT(J,2)=MIN THEN NREP=NREP+1
2250 NEXT J
2260 FOR J=BEGIN TO NREP+BEGIN-1
2270   SUM=SUM+J
2280 NEXT J
2290 DELTA=SUM/NREP
2300 FOR J=1 TO NV
2310   IF SORT(J,2)=MIN THEN SORT(J,1)=DELTA
2320   IF SORT(J,2)=MIN THEN SORT(J,2)=0
2330 NEXT J
2340 BEGIN=BEGIN+NREP
2350 NREP=0
2360 SUM=0
2370 IF BEGIN(=NV THEN GOTO 2190
2380 FOR J=1 TO NV
2390   KEN(J,EXEC)=SORT(J,1)
2400 NEXT J
2410 NEXT EXEC
2420 RETURN
2430 '
2440 '.............. CALCULATE W  ...  FOR NV VARIABLES AND NOB OB
SERVERS
2450 '
2460  '.............  INPUT  ...  VARIABLES  NV,  NOB,  AND  MATRIX
KEN(NV,NOB)
2470 '
2480 '.............. OUTPUT ... W
2490 '
2500 FOR J=1 TO 10 : R(J)=0 : S(J)=0 : NEXT J
2510 SUMS=0
2520 FOR J=1 TO NV
2530   FOR K=1 TO NOB
2540     R(J)=R(J)+KEN(J,K)
2550   NEXT K
2560 NEXT J
2570 FOR J=1 TO NV
2580   S(J)=(R(J)-NOB*(NV+1)/2)^2
2590   SUMS=SUMS+S(J)
2600 NEXT J
2610 W=12*SUMS/(NOB^2*NV*(NV^2-1))
2620  W1$="KENDALL'S  COEFFICIENT  OF  CONCORDANCE  STATICTIC,  W  =
```

```
#.###"
2630 PRINT
2640 PRINT USING W1$;W
2650 PRINT
2660 PRINT"See Table A.22, Page 472 of APPLIED NONPARAMETRIC STA-
TISTICS by Wayne E. Daniel (Houghton Mifflin Company, Boston, MA,
1978) to derive alpha."
2670 RETURN
2680 '
2690 '.....  STRING VARIABLE DATA - VARIABLE TITLES
2700 '
2710 '          MANNED                      UNMANNED
2720 DATA "b0 VALUE         ",          "b0 VALUE         "
2730 DATA "FINANCIAL (0-25)",          "FINANCIAL (0-23)"
2740 DATA "PROG MGT (0-12)",           "PROG MGT (0-10)"
2750 DATA "PROJ MGT (0-18)",           "PROJ MGT (0-18)"
2760 DATA "EXTRNL GOV (0-13)",         "EXTRNL GOV (0-11)"
2770 DATA "EXTRNL PUBLIC (0-9)",      "EXTRNL PUBLIC (0-10)"
2780 DATA "TECHNICAL (0-23)",          "TECHNICAL (0-22)"
2790 DATA "                 ",          "PUBLIC RLTNS (0-6)"
2800 FOR J=0 TO 7
2810   FOR K=1 TO 2
2820     READ W$(J,K)
2830   NEXT K
2840 NEXT J
2850 RETURN
2860 '
2870 ' .....  VIEW PREDICTOR VARIABLE FILE
2880 '
2890 PRINT
2900 PRINT"1.    SCREEN OUTPUT"
2910 PRINT
2920 PRINT"2.    PRINTED OUTPUT"
2930 PRINT
2940 GOSUB 1240
2950 ON IC GOSUB 2970,3190
2960 RETURN
2970  PRINT
2980 CLS : PRINT TAB(10)"MARSHALL SPACE FLIGHT CENTER ";
2990 PRINT "PROJECT SUCCESS PREDICTOR MODEL"
3000 PRINT
3010 PRINT TAB(10)"FILE NAME: ";FILE$;
3020 PRINT "     DATE: "DATE$ : PRINT
3030 IF RAW(1,1)=0 THEN GOSUB 360
3040 PRINT TAB(30);
3050 FOR J=1 TO NOB-1
3060   PRINT TAB(30+J*8);"EXEC ";J;
3070 NEXT J
3080 PRINT TAB(30+NOB*8);"EXEC ";NOB
3090 FOR I= 1 TO NV
3100 PRINT TAB(10) I;W$(I,NV-5);
3110   FOR J=1 TO NOB-1
3120     PRINT TAB(30+J*8);RAW(I,J);
3130   NEXT J
3140   PRINT TAB(30+NOB*8);RAW(I,NOB)
```

```
3150 NEXT I
3160 PRINT
3170 PRINT: PRINT"READY/ENTER"    :  GOSUB 1230
3180 GOTO 3410
3190 FOR J=1 TO 5 : LPRINT : NEXT
3200 LPRINT TAB(10)"MARSHALL SPACE FLIGHT CENTER"
3210 LPRINT TAB(10)"PROJECT SUCCESS PREDICTOR MODEL"
3220 LPRINT
3230 LPRINT TAB(10)"FILE NAME: ";FILE$
3240 LPRINT TAB(10)"DATE: "DATE$ : LPRINT
3250 IF RAW(1,1)=0 THEN GOSUB 360
3260 LPRINT TAB(27);
3270 FOR J=1 TO NOB-1
3280   LPRINT TAB(27+J*10);"EXEC ";J;
3290 NEXT J
3300 LPRINT TAB(27+NOB*10);"EXEC ";NOB
3310 LPRINT
3320 FOR I= 1 TO NV
3330 LPRINT TAB(10) I;W$(I,NV-5);
3340   FOR J=1 TO NOB-1
3350     LPRINT TAB(27+J*10);RAW(I,J);
3360   NEXT J
3370   LPRINT TAB(27+NOB*10);RAW(I,NOB)
3380 LPRINT
3390 NEXT I
3400 FOR J=1 TO 5 : LPRINT : NEXT J
3410 RETURN
3420 '
3430 ' .....                CHANGE CURRENT PREDICTOR VARIABLE
FILE
3440 '
3450 GOSUB 2970
3460 PRINT
3470 PRINT"WHICH VARIABLE,  1-";NV;:INPUT J
3480 PRINT"WHICH EXECUTIVE,  1-";NOB;:INPUT K
3490 INPUT"NEW WEIGHT";RAW(J,K)
3500 PRINT
3510 GOSUB 2970
3520 GOSUB 1970
3530 GOSUB 2460
3540 PRINT : PRINT"1=MORE CHANGES,     2=RETURN TO MAIN MENU"
3550 GOSUB 1230
3560 ON IC GOTO 3450,3570
3570 GOSUB 540
3580 RETURN
3590 '
3600 ' .....  PRINTED OUTPUT OF PREDICTOR VARIA-
BLES
3610 '
3620 FOR J=1 TO 5 : LPRINT : NEXT
3630 LPRINT TAB(10)"MARSHALL SPACE FLIGHT CENTER"
3640 LPRINT TAB(10)"PROJECT SUCCESS PREDICTOR MODEL"
3650 LPRINT
3660 LPRINT TAB(10)"FILE NAME: ";FILE$
3670 LPRINT TAB(10)"DATE: "DATE$ : LPRINT
```

```
3680 IF RAW(1,1)=0 THEN GOSUB 360
3690 LPRINT TAB(27);
3700 FOR J=1 TO NOB-1
3710   LPRINT TAB(27+J*10);"EXEC ";J;
3720 NEXT J
3730 LPRINT TAB(27+NOB*10);"EXEC ";NOB
3740 LPRINT
3750 FOR I= 1 TO NV
3760 LPRINT TAB(10) I;W$(I,NV-5);
3770   FOR J=1 TO NOB-1
3780     LPRINT TAB(27+J*10);KEN(I,J);
3790   NEXT J
3800   LPRINT TAB(27+NOB*10);KEN(I,NOB)
3810 LPRINT
3820 NEXT I
3830 FOR J=1 TO 5 : LPRINT : NEXT J
3840 RETURN
```

APPENDIX B

PHASE I

EXECUTIVE 1
MANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	15
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	15
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	20
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	15
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Tranferability of Results	10
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	20
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	5
TOTAL	100

EXECUTIVE 1
UNMANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	15
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	15
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	20
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	15
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Tranferability of Results	10
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	20
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	5
TOTAL	100

EXECUTIVE 2
MANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	35
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	5
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	10
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	5
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Tranferability of Results	5
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	30
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	10
TOTAL	100

EXECUTIVE 2
UNMANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	35
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	5
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	15
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	5
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Tranferability of Results	5
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	30
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	5
TOTAL	100

EXECUTIVE 3
MANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	20
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	12
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	20
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	15
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Tranferability of Results	10
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	15
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	8
TOTAL	100

EXECUTIVE 3
UNMANNED PROJECTS

VARIABLE	WEIGHT
FINANCIAL VARIABLE Availability of Funds at a Given Time Cost Experience/Schedule Status/ Cost and Schedule Realism Competition for Alternate uses of Funds	20
NASA PROGRAM MANAGEMENT VARIABLE Internal Support Window of Opportunity Congruence with NASA goals	10
NASA PROJECT MANAGEMENT VARIABLE Approach/Plan/Focus/Coordination Clarity of Requirements/ Goal Oriented/Schedule Realism Technical Staff Competence and Stability Contract Management	20
EXTERNAL GOVERNMENT ENVIRONMENT VARIABLE Consumer and Environmental Laws/ Government Laws/Government Regulations Top Management/Congressional Support Required Interface with Other Governmental Agencies	12
EXTERNAL PUBLIC ENVIRONMENT VARIABLE Public Interest Research Merit/Scientific Need/ Tranferability of Results	15
TECHNOLOGY VARIABLE State-of-the-art of Equipment, Theories,and Algorithms Amount of Technical Challenge Present Reliability Safety	15
PUBLIC RELATIONS VARIABLE Intrinsic Public Appeal Required Effort to Educate the Public Foreign/Commercial Success	8
TOTAL	100

PHASE II ROUND 1

EXECUTIVE 1

PROJECT	SCORE
MANNED:	
Apollo	190
Space Station	120
Shuttle Pre-Challenger	130
Shuttle Post-Challenger	140
UNMANNED:	
OMV	120
Hubble	185
HEAO	180
Galileo	170
Tethered Satellite	120

EXECUTIVE 2

PROJECT	SCORE
MANNED:	
Apollo	150
Space Station	75
Shuttle Pre-Challenger	100
Shuttle Post-Challenger	100
UNMANNED:	
OMV	100
Hubble	100
HEAO	175
Galileo	100
Tethered Satellite	100

EXECUTIVE 3

PROJECT	SCORE
MANNED:	
Apollo	200
Space Station	50
Shuttle Pre-Challenger	125
Shuttle Post-Challenger	125
UNMANNED:	
OMV	100
Hubble	150
HEAO	200
Galileo	90
Tethered Satellite	75

EXECUTIVE 4

PROJECT	SCORE
MANNED:	
Apollo	200
Space Station	50
Shuttle Pre-Challenger	175
Shuttle Post-Challenger	175
UNMANNED:	
OMV	100
Hubble	100
HEAO	200
Galileo	150
Tethered Satellite	50

PHASE II ROUND 2

EXECUTIVE 1

UNMANNED:

OMV	100
Hubble	185
HEAO	180
Galileo	130
Tethered Satellite	100

EXECUTIVE 2

UNMANNED:

OMV	115
Hubble	125
HEAO	175
Galileo	150
Tethered Satellite	100

EXECUTIVE 3

UNMANNED:

OMV	100
Hubble	150
HEAO	200
Galileo	90
Tethered Satellite	75

EXECUTIVE 4

UNMANNED:

OMV	100
Hubble	150
HEAO	200
Galileo	150
Tethered Satellite	75

PHASE III MANNED

MANNED PROJECTS - EXECUTIVE 1

VARIABLE	RANGE	APOLLO	SPACE STATION	SHUTTLE PRE CHALLENGER	SHUTTLE POST CHALLENGER
FINANCIAL	0-23	20	12	10	12
PROGRAM	0-11	11	9	8	10
PROJECT	0-17	16	10	14	15
EXT. GOVT.	0-12	12	8	10	11
EXT. PUBL.	0-8	7	5	6	6
TECHNOLOGY	0-22	20	12	16	10
PUBL. REL.	0-7	6	4	5	4
TOTAL	100				

MANNED PROJECTS - EXECUTIVE 2

VARIABLE	RANGE	APOLLO	SPACE STATION	SHUTTLE PRE CHALLENGER	SHUTTLE POST CHALLENGER
FINANCIAL	0-23	23	10	12	21
PROGRAM	0-11	11	8	8	8
PROJECT	0-17	15	14	8	15
EXT. GOVT.	0-12	12	11	10	10
EXT. PUBL.	0-8	8	3	5	7
TECHNOLOGY	0-22	20	5	15	5
PUBL. REL.	0-7	7	3	4	5
TOTAL	100				

MANNED PROJECTS - EXECUTIVE 3

VARIABLE	RANGE	APOLLO	SPACE STATION	SHUTTLE PRE CHALLENGER	SHUTTLE POST CHALLENGER
FINANCIAL	0-23	20	5	8	16
PROGRAM	0-11	11	4	5	10
PROJECT	0-17	15	6	8	8
EXT. GOVT.	0-12	11	6	7	7
EXT. PUBL.	0-8	7	3	5	5
TECHNOLOGY	0-22	20	20	15	15
PUBL. REL.	0-7	7	2	3	4
TOTAL	100				

MANNED PROJECTS - EXECUTIVE 4

VARIABLE	RANGE	APOLLO	SPACE STATION	SHUTTLE PRE CHALLENGER	SHUTTLE POST CHALLENGER
FINANCIAL	0-23	23	10	15	13
PROGRAM	0-11	11	7	10	8
PROJECT	0-17	17	7	15	13
EXT. GOVT.	0-12	12	7	10	8
EXT. PUBL.	0-8	8	6	7	6
TECHNOLOGY	0-22	22	20	20	20
PUBL. REL.	0-7	7	4	5	4
TOTAL	100				

PHASE III UNMANNED

UNMANNED PROJECTS - EXECUTIVE 1

VARIABLE	RANGE	HUBBLE	HEAO	GALILEO	TETHERED SATELLITE	OMV
FINANCIAL	0-23	10	19	17	12	12
PROGRAM	0-10	7	9	9	7	7
PROJECT	0-18	12	15	16	10	10
EXT. GOVT.	0-11	6	8	8	6	5
EXT. PUBL.	0-10	7	7	6	5	4
TECHNOLOGY	0-22	20	17	18	17	14
PUBL. REL.	0-6	5	4	4	3	3
TOTAL	100					

UNMANNED PROJECTS - EXECUTIVE 2

VARIABLE	RANGE	HUBBLE	HEAO	GALILEO	TETHERED SATELLITE	OMV
FINANCIAL	0-23	14	19	17	12	10
PROGRAM	0-10	7	8	7	6	4
PROJECT	0-18	10	15	13	10	9
EXT. GOVT.	0-11	9	9	9	8	8
EXT. PUBL.	0-10	9	9	9	9	6
TECHNOLOGY	0-22	10	15	15	15	15
PUBL. REL.	0-6	5	5	5	4	4
TOTAL	100					

UNMANNED PROJECTS - EXECUTIVE 3

VARIABLE	RANGE	HUBBLE	HEAO	GALILEO	TETHERED SATELLITE	OMV
FINANCIAL	0-23	15	18	5	5	5
PROGRAM	0-10	9	9	9	5	5
PROJECT	0-18	12	16	9	9	9
EXT. GOVT.	0-11	10	10	6	7	7
EXT. PUBL.	0-10	10	9	6	5	5
TECHNOLOGY	0-22	22	20	18	15	12
PUBL. REL.	0-6	6	5	4	4	4
TOTAL	100					

UNMANNED PROJECTS - EXECUTIVE 4

VARIABLE	RANGE	HUBBLE	HEAO	GALILEO	TETHERED SATELLITE	OMV
FINANCIAL	0-23	23	23	23	23	23
PROGRAM	0-10	10	10	10	7	5
PROJECT	0-18	18	18	18	10	15
EXT. GOVT.	0-11	9	9	9	5	5
EXT. PUBL.	0-10	8	7	8	3	3
TECHNOLOGY	0-22	20	20	20	20	20
PUBL. REL.	0-6	3	3	4	1	1
TOTAL	100					

PHASE III AVERAGES

MANNED PROJECTS - AVERAGES

VARIABLE	RANGE	APOLLO	SPACE STATION	SHUTTLE PRE CHALLENGER	SHUTTLE POST CHALLENGER
FINANCIAL	0-23	21.50	9.25	11.25	15.50
PROGRAM	0-11	11.00	7.00	7.75	9.00
PROJECT	0-17	15.75	9.25	11.25	12.75
EXT. GOVT.	0-12	11.75	8.00	9.25	9.00
EXT. PUBL.	0-8	7.50	4.25	5.75	6.00
TECHNOLOGY	0-22	20.50	14.25	16.50	12.50
PUBL. REL.	0-7	6.75	3.25	4.25	4.25
TOTAL	100				

UNMANNED PROJECTS - AVERAGES

VARIABLE	RANGE	HUBBLE	HEAO	GALILEO	TETHERED SATELLITE	OMV
FINANCIAL	0-23	15.50	19.75	15.50	13.00	12.50
PROGRAM	0-10	8.25	9.00	8.75	6.25	5.25
PROJECT	0-18	13.00	16.00	14.00	9.75	10.75
EXT. GOVT.	0-11	8.50	9.00	8.00	6.50	6.25
EXT. PUBL.	0-10	8.50	8.00	7.25	5.50	4.50
TECHNOLOGY	0-22	18.00	18.00	17.75	16.75	15.25
PUBL. REL.	0-6	4.75	4.25	4.25	3.00	3.00
TOTAL	100					

APPENDIX C

Appendix C contains the regression analysis results calculated for each of the possible combinations of six variables and five variables. The appendix is divided into two sections, the first containing the six variable combinations and the second representing the five variable combinations. For the purpose of identifying each analysis, a coding system was developed. Each variable is assigned a number as follows:

1	Financial
2	Program Management
3	Project Management
4	External Government
5	External Public
6	Technology
7	Public Relations

The digits appearing in the upper right corner of the analysis printout for each variable combination identify those variables which were included for that analysis.

SECTION I

REGRESSION ANALYSIS OF VARIANCE WITH 6 INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20775.5312	6.0000	3462.5886	1.8775
ABOUT	16597.9062	9.0000	1844.2118	
TOTAL	37373.4380	15.0000		

PR (F > 1.8775) = 0.1899

COEFFICIENTS OF REGRESSION:

B(0) = 24.9309
B(1) = -2.6690
B(2) = 6.6614
B(3) = 7.9521
B(4) = -12.2655
B(5) = 6.7365
B(6) = 15.0884

COEFFICIENT OF MULTIPLE CORRELATION = 0.7456
STANDARD ERROR OF THE ESTIMATE = 32.2082

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	20.0000	11.0000	16.0000	12.0000	7.0000	6.0000
120.0000	12.0000	9.0000	10.0000	8.0000	5.0000	4.0000
130.0000	10.0000	8.0000	14.0000	10.0000	6.0000	5.0000
140.0000	12.0000	10.0000	15.0000	11.0000	6.0000	4.0000
150.0000	23.0000	11.0000	15.0000	12.0000	8.0000	7.0000
75.0000	10.0000	8.0000	14.0000	11.0000	3.0000	3.0000
100.0000	12.0000	8.0000	8.0000	10.0000	5.0000	4.0000
100.0000	21.0000	8.0000	15.0000	10.0000	7.0000	5.0000
200.0000	20.0000	11.0000	15.0000	11.0000	7.0000	7.0000
50.0000	5.0000	4.0000	6.0000	6.0000	3.0000	2.0000
175.0000	8.0000	5.0000	8.0000	7.0000	5.0000	3.0000
125.0000	16.0000	10.0000	8.0000	7.0000	5.0000	4.0000
200.0000	23.0000	11.0000	17.0000	12.0000	8.0000	7.0000
50.0000	10.0000	7.0000	7.0000	7.0000	6.0000	4.0000
175.0000	15.0000	10.0000	15.0000	10.0000	7.0000	5.0000
175.0000	13.0000	8.0000	13.0000	8.0000	6.0000	4.0000

TABLE OF *RESIDUALS:*

Y	YC	R=Y-YC
190.0000	162.5609	27.4391
120.0000	128.2893	-8.2893
130.0000	156.0682	-26.0682
140.0000	144.6512	-4.6512
150.0000	168.4268	-18.4268
75.0000	93.4163	-18.4163
100.0000	81.1928	18.8072
100.0000	141.3982	-41.3982
200.0000	181.9627	18.0373
50.0000	62.7378	-12.7378
175.0000	93.5925	81.4075
125.0000	120.6361	4.3639
200.0000	184.3310	15.6690
50.0000	115.4502	-65.4502
175.0000	170.7348	4.2652
175.0000	149.5517	25.4483

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 6 INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22571.2539	6.0000	3761.8757	2.2873
ABOUT	14802.1846	9.0000	1644.6871	
TOTAL	37373.4380	15.0000		

PR (F > 2.2873) = 0.1275

COEFFICIENTS OF REGRESSION:

B(0) = -8.8721
B(1) = 0.0044
B(2) = 6.0140
B(3) = 9.7092
B(4) = -9.4111
B(5) = 3.1375
B(6) = 2.5330

COEFFICIENT OF MULTIPLE CORRELATION = 0.7771
STANDARD ERROR OF THE ESTIMATE = 30.4161

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	20.0000	11.0000	16.0000	12.0000	20.0000	6.0000
120.0000	12.0000	9.0000	10.0000	8.0000	12.0000	4.0000
130.0000	10.0000	8.0000	14.0000	10.0000	16.0000	5.0000
140.0000	12.0000	10.0000	15.0000	11.0000	10.0000	4.0000
150.0000	23.0000	11.0000	15.0000	12.0000	20.0000	7.0000
75.0000	10.0000	8.0000	14.0000	11.0000	5.0000	3.0000
100.0000	12.0000	8.0000	8.0000	10.0000	15.0000	4.0000
100.0000	21.0000	8.0000	15.0000	10.0000	5.0000	5.0000
200.0000	20.0000	11.0000	15.0000	11.0000	20.0000	7.0000
50.0000	5.0000	4.0000	6.0000	6.0000	20.0000	2.0000
175.0000	8.0000	5.0000	8.0000	7.0000	15.0000	3.0000
125.0000	16.0000	10.0000	8.0000	7.0000	15.0000	4.0000
200.0000	23.0000	11.0000	17.0000	12.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	7.0000	20.0000	4.0000
175.0000	15.0000	10.0000	15.0000	10.0000	20.0000	5.0000
175.0000	13.0000	8.0000	13.0000	8.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.7299	12.2701
120.0000	114.8906	5.1094
130.0000	143.9653	-13.9653
140.0000	134.9421	5.0579
150.0000	170.5668	-20.5668
75.0000	94.9759	-19.9759
100.0000	80.0485	19.9515
100.0000	119.2102	-19.2102
200.0000	179.9648	20.0352
50.0000	84.8095	-34.8095
175.0000	87.6895	87.3105
125.0000	120.3273	4.6727
200.0000	196.2601	3.7399
50.0000	108.2374	-58.2374
175.0000	178.2741	-3.2741
175.0000	163.1083	11.8917

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 6
INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22022.8750	6.0000	3670.4792	2.1520
ABOUT	15350.5635	9.0000	1705.6182	
TOTAL	37373.4380	15.0000		

PR (F > 2.1520) = 0.1450

COEFFICIENTS OF REGRESSION:

B(0) = -57.6010
B(1) = 0.2904
B(2) = 5.3770
B(3) = 6.4382
B(4) = 8.3968
B(5) = 3.5632
B(6) = -9.4238

COEFFICIENT OF MULTIPLE CORRELATION = 0.7676
STANDARD ERROR OF THE ESTIMATE = 30.9743

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	20.0000	11.0000	16.0000	7.0000	20.0000	6.0000
120.0000	12.0000	9.0000	10.0000	5.0000	12.0000	4.0000
130.0000	10.0000	8.0000	14.0000	6.0000	16.0000	5.0000
140.0000	12.0000	10.0000	15.0000	6.0000	10.0000	4.0000
150.0000	23.0000	11.0000	15.0000	8.0000	20.0000	7.0000
75.0000	10.0000	8.0000	14.0000	3.0000	5.0000	3.0000
100.0000	12.0000	8.0000	8.0000	5.0000	15.0000	4.0000
100.0000	21.0000	8.0000	15.0000	7.0000	5.0000	5.0000
200.0000	20.0000	11.0000	15.0000	7.0000	20.0000	7.0000
50.0000	5.0000	4.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	5.0000	8.0000	5.0000	15.0000	3.0000
125.0000	16.0000	10.0000	8.0000	5.0000	15.0000	4.0000
200.0000	23.0000	11.0000	17.0000	8.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	15.0000	10.0000	15.0000	7.0000	20.0000	5.0000
175.0000	13.0000	8.0000	13.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	183.8624	6.1376
120.0000	105.7050	14.2950
130.0000	138.7256	-8.7256
140.0000	144.5434	-4.5434
150.0000	177.2683	-27.2683
75.0000	93.1881	-18.1881
100.0000	98.1411	1.8589
100.0000	117.5599	-17.5599
200.0000	168.0004	31.9996
50.0000	81.5941	-31.5941
175.0000	90.2725	84.7275
125.0000	110.0566	14.9434
200.0000	197.2710	2.7290
50.0000	111.9578	-61.9578
175.0000	180.0192	-5.0192
175.0000	156.8351	18.1649

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 6 INDEPENDENT VARIABLES. 1-2-4-5-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	19462.9102	6.0000	3243.8184	1.6300
ABOUT	17910.5273	9.0000	1990.0586	
TOTAL	37373.4380	15.0000		

PR (F > 1.6300) = 0.2446

COEFFICIENTS OF REGRESSION:

B(0) = -55.8882
B(1) = -0.3932
B(2) = 7.6538
B(3) = 3.6376
B(4) = 13.5275
B(5) = 2.3979
B(6) = -4.8676

COEFFICIENT OF MULTIPLE CORRELATION = 0.7216
STANDARD ERROR OF THE ESTIMATE = 33.4576

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	20.0000	11.0000	12.0000	7.0000	20.0000	6.0000
120.0000	12.0000	9.0000	8.0000	5.0000	12.0000	4.0000
130.0000	10.0000	8.0000	10.0000	6.0000	16.0000	5.0000
140.0000	12.0000	10.0000	11.0000	6.0000	10.0000	4.0000
150.0000	23.0000	11.0000	12.0000	8.0000	20.0000	7.0000
75.0000	10.0000	8.0000	11.0000	3.0000	5.0000	3.0000
100.0000	12.0000	8.0000	10.0000	5.0000	15.0000	4.0000
100.0000	21.0000	8.0000	10.0000	7.0000	5.0000	5.0000
200.0000	20.0000	11.0000	11.0000	7.0000	20.0000	7.0000
50.0000	5.0000	4.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	5.0000	7.0000	5.0000	15.0000	3.0000
125.0000	16.0000	10.0000	7.0000	5.0000	15.0000	4.0000
200.0000	23.0000	11.0000	12.0000	8.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	15.0000	10.0000	10.0000	7.0000	20.0000	5.0000
175.0000	13.0000	8.0000	8.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.5363	12.4637
120.0000	114.3206	5.6794
130.0000	132.9799	-2.9799
140.0000	141.6188	-1.6188
150.0000	185.0166	-35.0166
75.0000	79.3932	-4.3932
100.0000	121.1358	-21.1358
100.0000	115.8053	-15.8053
200.0000	169.0311	30.9689
50.0000	73.3923	-23.3923
175.0000	93.7019	81.2981
125.0000	123.9580	1.0420
200.0000	189.8125	10.1875
50.0000	128.8726	-78.8726
175.0000	169.4408	5.5592
175.0000	138.9845	36.0155

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 6
INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	21992.6367	6.0000	3665.4395	2.1448
ABOUT	15380.8018	9.0000	1708.9780	
TOTAL	37373.4380	15.0000		

PR (F > 2.1448) = 0.1460

COEFFICIENTS OF REGRESSION:

B(0) = -4.2531
B(1) = 0.7140
B(2) = 9.5120
B(3) = -6.9494
B(4) = 3.0203
B(5) = 3.1096
B(6) = 2.3501

COEFFICIENT OF MULTIPLE CORRELATION = 0.7671
STANDARD ERROR OF THE ESTIMATE = 31.0048

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	20.0000	16.0000	12.0000	7.0000	20.0000	6.0000
120.0000	12.0000	10.0000	8.0000	5.0000	12.0000	4.0000
130.0000	10.0000	14.0000	10.0000	6.0000	16.0000	5.0000
140.0000	12.0000	15.0000	11.0000	6.0000	10.0000	4.0000
150.0000	23.0000	15.0000	12.0000	8.0000	20.0000	7.0000
75.0000	10.0000	14.0000	11.0000	3.0000	5.0000	3.0000
100.0000	12.0000	8.0000	10.0000	5.0000	15.0000	4.0000
100.0000	21.0000	15.0000	10.0000	7.0000	5.0000	5.0000
200.0000	20.0000	15.0000	11.0000	7.0000	20.0000	7.0000
50.0000	5.0000	6.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	8.0000	7.0000	5.0000	15.0000	3.0000
125.0000	16.0000	8.0000	7.0000	5.0000	15.0000	4.0000
200.0000	23.0000	17.0000	12.0000	8.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	15.0000	15.0000	10.0000	7.0000	20.0000	5.0000
175.0000	13.0000	13.0000	8.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	176.2627	13.7373
120.0000	105.6580	14.3420
130.0000	146.1880	-16.1880
140.0000	129.1707	10.8293
150.0000	174.2633	-24.2633
75.0000	91.2714	-16.2714
100.0000	82.0643	17.9357
100.0000	132.3687	-32.3687
200.0000	176.0502	23.9498
50.0000	90.6468	-40.6468
175.0000	97.7061	77.2939
125.0000	105.7685	19.2315
200.0000	199.5065	0.4935
50.0000	110.5408	-60.5408
175.0000	174.7291	0.2709
175.0000	162.8054	12.1946

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 6
INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22674.1484	6.0000	3779.0247	2.3138
ABOUT	14699.2891	9.0000	1633.2544	
TOTAL	37373.4380	15.0000		

PR (F > 2.3138) = 0.1243

COEFFICIENTS OF REGRESSION:

B(0) = -20.5415
B(1) = 6.2135
B(2) = 9.1169
B(3) = -8.1678
B(4) = 4.3794
B(5) = 3.1112
B(6) = -1.7628

COEFFICIENT OF MULTIPLE CORRELATION = 0.7789
STANDARD ERROR OF THE ESTIMATE = 30.3102

Y	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
190.0000	11.0000	16.0000	12.0000	7.0000	20.0000	6.0000
120.0000	9.0000	10.0000	8.0000	5.0000	12.0000	4.0000
130.0000	8.0000	14.0000	10.0000	6.0000	16.0000	5.0000
140.0000	10.0000	15.0000	11.0000	6.0000	10.0000	4.0000
150.0000	11.0000	15.0000	12.0000	8.0000	20.0000	7.0000
75.0000	8.0000	14.0000	11.0000	3.0000	5.0000	3.0000
100.0000	8.0000	8.0000	10.0000	5.0000	15.0000	4.0000
100.0000	8.0000	15.0000	10.0000	7.0000	5.0000	5.0000
200.0000	11.0000	15.0000	11.0000	7.0000	20.0000	7.0000
50.0000	4.0000	6.0000	6.0000	3.0000	20.0000	2.0000
175.0000	5.0000	8.0000	7.0000	5.0000	15.0000	3.0000
125.0000	10.0000	8.0000	7.0000	5.0000	15.0000	4.0000
200.0000	11.0000	17.0000	12.0000	8.0000	22.0000	7.0000
50.0000	7.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	10.0000	15.0000	10.0000	7.0000	20.0000	5.0000
175.0000	8.0000	13.0000	8.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.9675	12.0325
120.0000	113.3872	6.6128
130.0000	142.3672	-12.3672
140.0000	138.8387	1.1613
150.0000	171.4671	-21.4671
75.0000	90.3632	-15.3632
100.0000	81.9379	18.0621
100.0000	121.6397	-21.6397
200.0000	175.2556	24.7444
50.0000	81.8444	-31.8444
175.0000	89.5636	85.4364
125.0000	118.8685	6.1315
200.0000	195.9234	4.0766
50.0000	111.0466	-61.0466
175.0000	180.7355	-5.7355
175.0000	163.7937	11.2063

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

SECTION II

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-2-3-4-5

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20038.5938	5.0000	4007.7188	2.3119
ABOUT	17334.8438	10.0000	1733.4844	
TOTAL	37373.4380	15.0000		

PR (F > 2.3119) = 0.1215

COEFFICIENTS OF REGRESSION:

B(0) = 8.3228
B(1) = -0.7870
B(2) = 7.2695
B(3) = 6.8209
B(4) = -8.9105
B(5) = 12.7876

COEFFICIENT OF MULTIPLE CORRELATION = 0.7322
STANDARD ERROR OF THE ESTIMATE = 32.9155

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	16.0000	12.0000	7.0000
120.0000	12.0000	9.0000	10.0000	8.0000	5.0000
130.0000	10.0000	8.0000	14.0000	10.0000	6.0000
140.0000	12.0000	10.0000	15.0000	11.0000	6.0000
150.0000	23.0000	11.0000	15.0000	12.0000	8.0000
75.0000	10.0000	8.0000	14.0000	11.0000	3.0000
100.0000	12.0000	8.0000	8.0000	10.0000	5.0000
100.0000	21.0000	8.0000	15.0000	10.0000	7.0000
200.0000	20.0000	11.0000	15.0000	11.0000	7.0000
50.0000	5.0000	4.0000	6.0000	6.0000	3.0000
175.0000	8.0000	5.0000	8.0000	7.0000	5.0000
125.0000	16.0000	10.0000	8.0000	7.0000	5.0000
200.0000	23.0000	11.0000	17.0000	12.0000	8.0000
50.0000	10.0000	7.0000	7.0000	7.0000	6.0000
175.0000	5.0000	10.0000	15.0000	10.0000	7.0000
175.0000	13.0000	8.0000	13.0000	8.0000	6.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	164.2672	25.7328
120.0000	125.1663	-5.1663
130.0000	141.7208	-11.7208
140.0000	152.5961	-12.5961
150.0000	167.8728	-17.8728
75.0000	94.4475	-19.4475
100.0000	86.4339	13.5661
100.0000	152.6718	-52.6718
200.0000	166.3569	33.6431
50.0000	59.2904	-9.2904
175.0000	94.5051	80.4949
125.0000	124.5565	0.4435
200.0000	181.5145	18.4855
50.0000	113.4368	-63.4368
175.0000	179.8034	-4.8034
175.0000	150.3599	24.6401

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-2-3-4-6

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22572.2070	5.0000	4514.4414	3.0500
ABOUT	14801.2305	10.0000	1480.1231	
TOTAL	37373.4380	15.0000		

PR (F > 3.0500) = 0.0628

COEFFICIENTS OF REGRESSION:

B(0) = -12.7268
B(1) = 0.3793
B(2) = 6.2184
B(3) = 9.9237
B(4) = -9.1730
B(5) = 3.3728

COEFFICIENT OF MULTIPLE CORRELATION = 0.7772
STANDARD ERROR OF THE ESTIMATE = 30.4151

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	16.0000	12.0000	20.0000
120.0000	12.0000	9.0000	10.0000	8.0000	12.0000
130.0000	10.0000	8.0000	14.0000	10.0000	16.0000
140.0000	12.0000	10.0000	15.0000	11.0000	10.0000
150.0000	23.0000	11.0000	15.0000	12.0000	20.0000
75.0000	10.0000	8.0000	14.0000	11.0000	5.0000
100.0000	12.0000	8.0000	8.0000	10.0000	15.0000
100.0000	21.0000	8.0000	15.0000	10.0000	5.0000
200.0000	20.0000	11.0000	15.0000	11.0000	20.0000
50.0000	5.0000	4.0000	6.0000	6.0000	20.0000
175.0000	8.0000	5.0000	8.0000	7.0000	15.0000
125.0000	16.0000	10.0000	8.0000	7.0000	15.0000
200.0000	23.0000	11.0000	17.0000	12.0000	22.0000
50.0000	10.0000	7.0000	7.0000	7.0000	20.0000
175.0000	5.0000	10.0000	15.0000	10.0000	20.0000
175.0000	13.0000	8.0000	13.0000	8.0000	20.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	179.4217	10.5783
120.0000	114.1175	5.8825
130.0000	141.9809	-11.9809
140.0000	135.6899	4.3101
150.0000	170.6359	-20.6359
75.0000	95.7067	-20.7067
100.0000	79.8242	20.1758
100.0000	118.9756	-18.9756
200.0000	178.6710	21.3290
50.0000	86.0044	-36.0044
175.0000	87.1709	87.8291
125.0000	121.2971	3.7029
200.0000	197.2290	2.7710
50.0000	107.3067	-57.3067
175.0000	175.9362	-0.9362
175.0000	165.0323	9.9677

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-2-3-4-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20586.0293	5.0000	4117.2061	2.4526
ABOUT	16787.4082	10.0000	1678.7408	
TOTAL	37373.4380	15.0000		

PR (F > 2.4526) = 0.1066

COEFFICIENTS OF REGRESSION:

B(0) = 45.6071
B(1) = -1.6423
B(2) = 5.0627
B(3) = 8.0471
B(4) = -12.9331
B(5) = 19.8846

COEFFICIENT OF MULTIPLE CORRELATION = 0.7422
STANDARD ERROR OF THE ESTIMATE = 32.3916

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	16.0000	12.0000	6.0000
120.0000	12.0000	9.0000	10.0000	8.0000	4.0000
130.0000	10.0000	8.0000	14.0000	10.0000	5.0000
140.0000	12.0000	10.0000	15.0000	11.0000	4.0000
150.0000	23.0000	11.0000	15.0000	12.0000	7.0000
75.0000	10.0000	8.0000	14.0000	11.0000	3.0000
100.0000	12.0000	8.0000	8.0000	10.0000	4.0000
100.0000	21.0000	8.0000	15.0000	10.0000	5.0000
200.0000	20.0000	11.0000	15.0000	11.0000	7.0000
50.0000	5.0000	4.0000	6.0000	6.0000	2.0000
175.0000	8.0000	5.0000	8.0000	7.0000	3.0000
125.0000	16.0000	10.0000	8.0000	7.0000	4.0000
200.0000	23.0000	11.0000	17.0000	12.0000	7.0000
50.0000	10.0000	7.0000	7.0000	7.0000	4.0000
175.0000	5.0000	10.0000	15.0000	10.0000	5.0000
175.0000	13.0000	8.0000	13.0000	8.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	161.3162	28.6838
120.0000	128.0092	-8.0092
130.0000	152.4381	-22.4381
140.0000	134.5083	5.4917
150.0000	168.2269	-18.2269
75.0000	99.7358	-24.7358
100.0000	80.9861	19.0139
100.0000	142.4203	-42.4203
200.0000	186.0867	13.9133
50.0000	68.1001	-18.1001
175.0000	91.2818	83.7182
125.0000	123.3415	1.6585
200.0000	184.3212	15.6788
50.0000	109.9600	-59.9600
175.0000	178.8219	-3.8219
175.0000	145.4457	29.5543

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-2-3-5-6

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	21772.2461	5.0000	4354.4492	2.7911
ABOUT	15601.1914	10.0000	1560.1191	
TOTAL	37373.4380	15.0000		

PR (F > 2.7911) = 0.0785

COEFFICIENTS OF REGRESSION:

B(0) = -43.9788
B(1) = -0.3609
B(2) = 3.8922
B(3) = 5.7980
B(4) = 5.0494
B(5) = 3.0823

COEFFICIENT OF MULTIPLE CORRELATION = 0.7633
STANDARD ERROR OF THE ESTIMATE = 31.2262

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	16.0000	7.0000	20.0000
120.0000	12.0000	9.0000	10.0000	5.0000	12.0000
130.0000	10.0000	8.0000	14.0000	6.0000	16.0000
140.0000	12.0000	10.0000	15.0000	6.0000	10.0000
150.0000	23.0000	11.0000	15.0000	8.0000	20.0000
75.0000	10.0000	8.0000	14.0000	3.0000	5.0000
100.0000	12.0000	8.0000	8.0000	5.0000	15.0000
100.0000	21.0000	8.0000	15.0000	7.0000	5.0000
200.0000	20.0000	11.0000	15.0000	7.0000	20.0000
50.0000	5.0000	4.0000	6.0000	3.0000	20.0000
175.0000	8.0000	5.0000	8.0000	5.0000	15.0000
125.0000	16.0000	10.0000	8.0000	5.0000	15.0000
200.0000	23.0000	11.0000	17.0000	8.0000	22.0000
50.0000	10.0000	7.0000	7.0000	6.0000	20.0000
175.0000	5.0000	10.0000	15.0000	7.0000	20.0000
175.0000	13.0000	8.0000	13.0000	6.0000	20.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	181.3776	8.6224
120.0000	106.9350	13.0650
130.0000	144.3352	-14.3352
140.0000	138.7018	1.2982
150.0000	179.5464	-29.5464
75.0000	95.2813	-20.2813
100.0000	100.6939	-0.6939
100.0000	117.3072	-17.3072
200.0000	175.5796	24.4204
50.0000	81.3682	-31.3682
175.0000	90.4609	84.5391
125.0000	107.0347	17.9653
200.0000	197.3070	2.6930
50.0000	112.1866	-62.1866
175.0000	177.1008	-2.1008
175.0000	149.7839	25.2161

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	19267.5117	5.0000	3853.5024	2.1283
ABOUT	18105.9258	10.0000	1810.5925	
TOTAL	37373.4380	15.0000		

PR (F > 2.1283) = 0.1448

COEFFICIENTS OF REGRESSION:

B(0) = -12.7349
B(1) = -1.6930
B(2) = 3.9969
B(3) = 3.0720
B(4) = 10.9399
B(5) = 7.3672

COEFFICIENT OF MULTIPLE CORRELATION = 0.7180
STANDARD ERROR OF THE ESTIMATE = 33.6396

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	16.0000	7.0000	6.0000
120.0000	12.0000	9.0000	10.0000	5.0000	4.0000
130.0000	10.0000	8.0000	14.0000	6.0000	5.0000
140.0000	12.0000	10.0000	15.0000	6.0000	4.0000
150.0000	23.0000	11.0000	15.0000	8.0000	7.0000
75.0000	10.0000	8.0000	14.0000	3.0000	3.0000
100.0000	12.0000	8.0000	8.0000	5.0000	4.0000
100.0000	21.0000	8.0000	15.0000	7.0000	5.0000
200.0000	20.0000	11.0000	15.0000	7.0000	7.0000
50.0000	5.0000	4.0000	6.0000	3.0000	2.0000
175.0000	8.0000	5.0000	8.0000	5.0000	3.0000
125.0000	16.0000	10.0000	8.0000	5.0000	4.0000
200.0000	23.0000	11.0000	17.0000	8.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	4.0000
175.0000	5.0000	10.0000	15.0000	7.0000	5.0000
175.0000	13.0000	8.0000	13.0000	6.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	167.3067	22.6933
120.0000	117.8102	2.1898
130.0000	147.7946	-17.7946
140.0000	148.1072	-8.1072
150.0000	177.4628	-27.4628
75.0000	100.2404	-25.2404
100.0000	107.6692	-7.6692
100.0000	143.1838	-43.1838
200.0000	171.6018	28.3982
50.0000	60.7742	-10.7742
175.0000	95.0833	79.9167
125.0000	108.8911	16.1089
200.0000	183.6069	16.3931
50.0000	114.9262	-64.9262
175.0000	178.2652	-3.2652
175.0000	132.2764	42.7236

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	21570.0664	5.0000	4314.0132	2.7298
ABOUT	15803.3701	10.0000	1580.3370	
TOTAL	37373.4380	15.0000		

PR (F > 2.7298) = 0.0829

COEFFICIENTS OF REGRESSION:

B(0) = -46.0674
B(1) = 0.4025
B(2) = 4.8166
B(3) = 6.9931
B(4) = 3.8622
B(5) = -2.9930

COEFFICIENT OF MULTIPLE CORRELATION = 0.7597
STANDARD ERROR OF THE ESTIMATE = 31.4279

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	16.0000	20.0000	6.0000
120.0000	12.0000	9.0000	10.0000	12.0000	4.0000
130.0000	10.0000	8.0000	14.0000	16.0000	5.0000
140.0000	12.0000	10.0000	15.0000	10.0000	4.0000
150.0000	23.0000	11.0000	15.0000	20.0000	7.0000
75.0000	10.0000	8.0000	14.0000	5.0000	3.0000
100.0000	12.0000	8.0000	8.0000	15.0000	4.0000
100.0000	21.0000	8.0000	15.0000	5.0000	5.0000
200.0000	20.0000	11.0000	15.0000	20.0000	7.0000
50.0000	5.0000	4.0000	6.0000	20.0000	2.0000
175.0000	8.0000	5.0000	8.0000	15.0000	3.0000
125.0000	16.0000	10.0000	8.0000	15.0000	4.0000
200.0000	23.0000	11.0000	17.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	20.0000	4.0000
175.0000	5.0000	10.0000	15.0000	20.0000	5.0000
175.0000	13.0000	8.0000	13.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	186.1404	3.8596
120.0000	106.4170	13.5830
130.0000	141.2235	-11.2235
140.0000	138.4744	1.5256
150.0000	177.3618	-27.3618
75.0000	104.7251	-29.7251
100.0000	99.2010	0.7990
100.0000	110.1598	-10.1598
200.0000	176.1543	23.8457
50.0000	88.4282	-38.4282
175.0000	86.1343	88.8657
125.0000	110.4442	14.5558
200.0000	199.0724	0.9276
50.0000	105.8975	-55.8975
175.0000	171.2860	3.7140
175.0000	153.8799	21.1201

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	19482.3555	5.0000	3896.4712	2.1779
ABOUT	17891.0820	10.0000	1789.1082	
TOTAL	37373.4380	15.0000		

PR (F > 2.1779) = 0.1381

COEFFICIENTS OF REGRESSION:

B(0) = -45.2083
B(1) = -0.7677
B(2) = 7.1103
B(3) = 2.7881
B(4) = 11.7209
B(5) = 2.0916

COEFFICIENT OF MULTIPLE CORRELATION = 0.7220
STANDARD ERROR OF THE ESTIMATE = 33.4394

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	12.0000	7.0000	20.0000
120.0000	12.0000	9.0000	8.0000	5.0000	12.0000
130.0000	10.0000	8.0000	10.0000	6.0000	16.0000
140.0000	12.0000	10.0000	11.0000	6.0000	10.0000
150.0000	23.0000	11.0000	12.0000	8.0000	20.0000
75.0000	10.0000	8.0000	11.0000	3.0000	5.0000
100.0000	12.0000	8.0000	10.0000	5.0000	15.0000
100.0000	21.0000	8.0000	10.0000	7.0000	5.0000
200.0000	20.0000	11.0000	11.0000	7.0000	20.0000
50.0000	5.0000	4.0000	6.0000	3.0000	20.0000
175.0000	8.0000	5.0000	7.0000	5.0000	15.0000
125.0000	16.0000	10.0000	7.0000	5.0000	15.0000
200.0000	23.0000	11.0000	12.0000	8.0000	22.0000
50.0000	10.0000	7.0000	7.0000	6.0000	20.0000
175.0000	5.0000	10.0000	10.0000	7.0000	20.0000
175.0000	13.0000	8.0000	8.0000	6.0000	20.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	174.9849	15.0151
120.0000	115.5796	4.4204
130.0000	135.6681	-5.6681
140.0000	138.5918	1.4082
150.0000	184.4026	-34.4026
75.0000	80.2861	-5.2861
100.0000	120.3201	-20.3201
100.0000	115.9365	-15.9365
200.0000	172.1968	27.8032
50.0000	73.1168	-23.1168
175.0000	93.6959	81.3041
125.0000	123.1055	1.8945
200.0000	188.5857	11.4143
50.0000	128.5598	-78.5598
175.0000	173.8146	1.1854
175.0000	136.1550	38.8450

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-2-4-5-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	18466.2109	5.0000	3693.2422	1.9533
ABOUT	18907.2266	10.0000	1890.7227	
TOTAL	37373.4380	15.0000		

PR (F > 1.9533) = 0.1720

COEFFICIENTS OF REGRESSION:

B(0) = -5.9606
B(1) = -1.8309
B(2) = 6.5587
B(3) = -0.9163
B(4) = 11.6046
B(5) = 10.6751

COEFFICIENT OF MULTIPLE CORRELATION = 0.7029
STANDARD ERROR OF THE ESTIMATE = 34.3759

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	12.0000	7.0000	6.0000
120.0000	12.0000	9.0000	8.0000	5.0000	4.0000
130.0000	10.0000	8.0000	10.0000	6.0000	5.0000
140.0000	12.0000	10.0000	11.0000	6.0000	4.0000
150.0000	23.0000	11.0000	12.0000	8.0000	7.0000
75.0000	10.0000	8.0000	11.0000	3.0000	3.0000
100.0000	12.0000	8.0000	10.0000	5.0000	4.0000
100.0000	21.0000	8.0000	10.0000	7.0000	5.0000
200.0000	20.0000	11.0000	11.0000	7.0000	7.0000
50.0000	5.0000	4.0000	6.0000	3.0000	2.0000
175.0000	8.0000	5.0000	7.0000	5.0000	3.0000
125.0000	16.0000	10.0000	7.0000	5.0000	4.0000
200.0000	23.0000	11.0000	12.0000	8.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	4.0000
175.0000	5.0000	10.0000	10.0000	7.0000	5.0000
175.0000	13.0000	8.0000	8.0000	6.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	163.8539	26.1461
120.0000	124.4897	-4.4897
130.0000	142.0399	-12.0399
140.0000	139.9041	0.0959
150.0000	180.6409	-30.6409
75.0000	84.9594	-9.9594
100.0000	116.0983	-16.0983
100.0000	133.5044	-33.5044
200.0000	175.4454	24.5546
50.0000	61.7858	-11.7858
175.0000	95.8198	79.1802
125.0000	124.6411	0.3589
200.0000	180.6409	19.3591
50.0000	127.5551	-77.5551
175.0000	175.9166	-0.9166
175.0000	127.7047	47.2953

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-2-4-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	18501.4297	5.0000	3700.2859	1.9607
ABOUT	18872.0078	10.0000	1887.2008	
TOTAL	37373.4380	15.0000		

PR (F > 1.9607) = 0.1707

COEFFICIENTS OF REGRESSION:

B(0) = -17.4462
B(1) = -0.9621
B(2) = 7.0398
B(3) = 1.4875
B(4) = 2.0500
B(5) = 12.4111

COEFFICIENT OF MULTIPLE CORRELATION = 0.7036
STANDARD ERROR OF THE ESTIMATE = 34.3439

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	12.0000	20.0000	6.0000
120.0000	12.0000	9.0000	8.0000	12.0000	4.0000
130.0000	10.0000	8.0000	10.0000	16.0000	5.0000
140.0000	12.0000	10.0000	11.0000	10.0000	4.0000
150.0000	23.0000	11.0000	12.0000	20.0000	7.0000
75.0000	10.0000	8.0000	11.0000	5.0000	3.0000
100.0000	12.0000	8.0000	10.0000	15.0000	4.0000
100.0000	21.0000	8.0000	10.0000	5.0000	5.0000
200.0000	20.0000	11.0000	11.0000	20.0000	7.0000
50.0000	5.0000	4.0000	6.0000	20.0000	2.0000
175.0000	8.0000	5.0000	7.0000	15.0000	3.0000
125.0000	16.0000	10.0000	7.0000	15.0000	4.0000
200.0000	23.0000	11.0000	12.0000	22.0000	7.0000
50.0000	10.0000	7.0000	7.0000	20.0000	4.0000
175.0000	5.0000	10.0000	10.0000	20.0000	5.0000
175.0000	13.0000	8.0000	8.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	174.0660	15.9340
120.0000	120.5110	-0.5110
130.0000	138.9815	-8.9815
140.0000	127.9131	12.0869
150.0000	183.5909	-33.5909
75.0000	93.0965	-18.0965
100.0000	122.5962	-22.5962
100.0000	105.8483	-5.8483
200.0000	184.9897	15.0103
50.0000	80.6498	-30.6498
175.0000	88.4518	86.5482
125.0000	128.3650	-3.3650
200.0000	187.6909	12.3091
50.0000	123.2683	-73.2683
175.0000	166.0716	8.9284
175.0000	128.9093	46.0907

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES.

1-2-5-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20836.9727	5.0000	4167.3945	2.5201
ABOUT	16536.4648	10.0000	1653.6465	
TOTAL	37373.4380	15.0000		

PR (F > 2.5201) = 0.1001

COEFFICIENTS OF REGRESSION:

B(0) = 28.3655
B(1) = 1.5037
B(2) = 7.7212
B(3) = 5.6078
B(4) = 1.7601
B(5) = -11.7046

COEFFICIENT OF MULTIPLE CORRELATION = 0.7467
STANDARD ERROR OF THE ESTIMATE = 32.1485

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	11.0000	7.0000	20.0000	4.0000
120.0000	12.0000	9.0000	5.0000	12.0000	4.0000
130.0000	10.0000	8.0000	6.0000	16.0000	3.0000
140.0000	12.0000	10.0000	6.0000	10.0000	3.0000
150.0000	23.0000	11.0000	8.0000	20.0000	5.0000
75.0000	10.0000	8.0000	3.0000	5.0000	5.0000
100.0000	12.0000	8.0000	5.0000	15.0000	4.0000
100.0000	21.0000	8.0000	7.0000	5.0000	4.0000
200.0000	20.0000	11.0000	7.0000	20.0000	5.0000
50.0000	5.0000	4.0000	3.0000	20.0000	4.0000
175.0000	8.0000	5.0000	5.0000	15.0000	4.0000
125.0000	16.0000	10.0000	5.0000	15.0000	4.0000
200.0000	23.0000	11.0000	8.0000	22.0000	3.0000
50.0000	10.0000	7.0000	6.0000	20.0000	4.0000
175.0000	5.0000	10.0000	7.0000	20.0000	1.0000
175.0000	13.0000	8.0000	6.0000	20.0000	1.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	171.0107	18.9893
120.0000	118.2424	1.7576
130.0000	131.8668	-1.8668
140.0000	139.7558	0.2442
150.0000	169.4249	-19.4249
75.0000	72.2729	2.7271
100.0000	115.8016	-15.8016
100.0000	122.9489	-22.9489
200.0000	159.3061	40.6939
50.0000	71.9762	-21.9762
175.0000	86.6234	88.3766
125.0000	137.2586	-12.2586
200.0000	196.3543	3.6457
50.0000	119.4815	-69.4815
175.0000	175.8484	-0.8484
175.0000	166.8274	8.1726

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-3-4-5-6

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	21951.9707	5.0000	4390.3940	2.8469
ABOUT	15421.4668	10.0000	1542.1467	
TOTAL	37373.4380	15.0000		

PR (F > 2.8469) = 0.0748

COEFFICIENTS OF REGRESSION:

B(0) = -11.3778
B(1) = 0.5724
B(2) = 9.6631
B(3) = -6.3532
B(4) = 4.8168
B(5) = 3.2551

COEFFICIENT OF MULTIPLE CORRELATION = 0.7664
STANDARD ERROR OF THE ESTIMATE = 31.0458

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	16.0000	12.0000	7.0000	20.0000
120.0000	12.0000	10.0000	8.0000	5.0000	12.0000
130.0000	10.0000	14.0000	10.0000	6.0000	16.0000
140.0000	12.0000	15.0000	11.0000	6.0000	10.0000
150.0000	23.0000	15.0000	12.0000	8.0000	20.0000
75.0000	10.0000	14.0000	11.0000	3.0000	5.0000
100.0000	12.0000	8.0000	10.0000	5.0000	15.0000
100.0000	21.0000	15.0000	10.0000	7.0000	5.0000
200.0000	20.0000	15.0000	11.0000	7.0000	20.0000
50.0000	5.0000	6.0000	6.0000	3.0000	20.0000
175.0000	8.0000	8.0000	7.0000	5.0000	15.0000
125.0000	16.0000	8.0000	7.0000	5.0000	15.0000
200.0000	23.0000	17.0000	12.0000	8.0000	22.0000
50.0000	10.0000	7.0000	7.0000	6.0000	20.0000
175.0000	5.0000	15.0000	10.0000	7.0000	20.0000
175.0000	13.0000	13.0000	8.0000	6.0000	20.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.2614	12.7386
120.0000	104.4419	15.5581
130.0000	147.0805	-17.0805
140.0000	132.0046	7.9954
150.0000	174.1323	-24.1323
75.0000	90.4708	-15.4708
100.0000	82.1747	17.8253
100.0000	132.0506	-32.0506
200.0000	173.9514	26.0486
50.0000	90.8962	-40.8962
175.0000	98.9446	76.0554
125.0000	103.5237	21.4763
200.0000	199.9687	0.0313
50.0000	111.5186	-61.5186
175.0000	171.7189	3.2811
175.0000	164.8612	10.1388

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-3-4-5-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20171.7949	5.0000	4034.3589	2.3453
ABOUT	17201.6426	10.0000	1720.1643	
TOTAL	37373.4380	15.0000		

PR (F > 2.3453) = 0.1178

COEFFICIENTS OF REGRESSION:

B(0) = 45.9843
B(1) = -1.4632
B(2) = 7.9106
B(3) = -10.6578
B(4) = 3.5773
B(5) = 19.9242

COEFFICIENT OF MULTIPLE CORRELATION = 0.7347
STANDARD ERROR OF THE ESTIMATE = 32.7888

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	16.0000	12.0000	7.0000	6.0000
120.0000	12.0000	10.0000	8.0000	5.0000	4.0000
130.0000	10.0000	14.0000	10.0000	6.0000	5.0000
140.0000	12.0000	15.0000	11.0000	6.0000	4.0000
150.0000	23.0000	15.0000	12.0000	8.0000	7.0000
75.0000	10.0000	14.0000	11.0000	3.0000	3.0000
100.0000	12.0000	8.0000	10.0000	5.0000	4.0000
100.0000	21.0000	15.0000	10.0000	7.0000	5.0000
200.0000	20.0000	15.0000	11.0000	7.0000	7.0000
50.0000	5.0000	6.0000	6.0000	3.0000	2.0000
175.0000	8.0000	8.0000	7.0000	5.0000	3.0000
125.0000	16.0000	8.0000	7.0000	5.0000	4.0000
200.0000	23.0000	17.0000	12.0000	8.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	4.0000
175.0000	5.0000	15.0000	10.0000	7.0000	5.0000
175.0000	13.0000	13.0000	8.0000	6.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	159.9830	30.0170
120.0000	119.8531	0.1469
130.0000	156.6080	-26.6080
140.0000	131.0103	8.9897
150.0000	171.1843	-21.1842
75.0000	95.3699	-20.3699
100.0000	82.7163	17.2837
100.0000	152.0006	-52.0006
200.0000	182.6544	17.3456
50.0000	72.7657	-22.7657
175.0000	100.6183	74.3817
125.0000	108.8367	16.1633
200.0000	187.0055	12.9945
50.0000	113.2828	-63.2828
175.0000	175.4121	-0.4121
175.0000	145.6991	29.3009

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-3-4-5-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20171.7949	5.0000	4034.3589	2.3453
ABOUT	17201.6426	10.0000	1720.1643	
TOTAL	37373.4380	15.0000		

PR (F > 2.3453) = 0.1178

COEFFICIENTS OF REGRESSION:

B(0) = 45.9843
B(1) = -1.4632
B(2) = 7.9106
B(3) = -10.6578
B(4) = 3.5773
B(5) = 19.9242

COEFFICIENT OF MULTIPLE CORRELATION = 0.7347
STANDARD ERROR OF THE ESTIMATE = 32.7888

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	16.0000	12.0000	7.0000	6.0000
120.0000	12.0000	10.0000	8.0000	5.0000	4.0000
130.0000	10.0000	14.0000	10.0000	6.0000	5.0000
140.0000	12.0000	15.0000	11.0000	6.0000	4.0000
150.0000	23.0000	15.0000	12.0000	8.0000	7.0000
75.0000	10.0000	14.0000	11.0000	3.0000	3.0000
100.0000	12.0000	8.0000	10.0000	5.0000	4.0000
100.0000	21.0000	15.0000	10.0000	7.0000	5.0000
200.0000	20.0000	15.0000	11.0000	7.0000	7.0000
50.0000	5.0000	6.0000	6.0000	3.0000	2.0000
175.0000	8.0000	8.0000	7.0000	5.0000	3.0000
125.0000	16.0000	8.0000	7.0000	5.0000	4.0000
200.0000	23.0000	17.0000	12.0000	8.0000	7.0000
50.0000	10.0000	7.0000	7.0000	6.0000	4.0000
175.0000	5.0000	15.0000	10.0000	7.0000	5.0000
175.0000	13.0000	13.0000	8.0000	6.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	175.6676	14.3324
120.0000	107.4041	12.5959
130.0000	149.9745	-19.9745
140.0000	127.3151	12.6849
150.0000	173.1793	-23.1793
75.0000	94.5825	-19.5825
100.0000	80.1823	19.8177
100.0000	129.3534	-29.3534
200.0000	180.4823	19.5177
50.0000	92.3794	-42.3794
175.0000	96.6892	78.3108
125.0000	105.6554	19.3446
200.0000	199.4777	0.5223
50.0000	109.2543	-59.2543
175.0000	170.9495	4.0505
175.0000	162.4534	12.5466

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 1-3-5-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	21478.2812	5.0000	4295.6562	2.7025
ABOUT	15895.1553	10.0000	1589.5155	
TOTAL	37373.4380	15.0000		

PR (F > 2.7025) = 0.0849

COEFFICIENTS OF REGRESSION:

B(0) = -40.4333
B(1) = 0.4977
B(2) = 7.2806
B(3) = 7.4240
B(4) = 3.4917
B(5) = -4.3623

COEFFICIENT OF MULTIPLE CORRELATION = 0.7581
STANDARD ERROR OF THE ESTIMATE = 31.5190

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	16.0000	7.0000	20.0000	6.0000
120.0000	12.0000	10.0000	5.0000	12.0000	4.0000
130.0000	10.0000	14.0000	6.0000	16.0000	5.0000
140.0000	12.0000	15.0000	6.0000	10.0000	4.0000
150.0000	23.0000	15.0000	8.0000	20.0000	7.0000
75.0000	10.0000	14.0000	3.0000	5.0000	3.0000
100.0000	12.0000	8.0000	5.0000	15.0000	4.0000
100.0000	21.0000	15.0000	7.0000	5.0000	5.0000
200.0000	20.0000	15.0000	7.0000	20.0000	7.0000
50.0000	5.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	8.0000	5.0000	15.0000	3.0000
125.0000	16.0000	8.0000	5.0000	15.0000	4.0000
200.0000	23.0000	17.0000	8.0000	22.0000	7.0000
50.0000	10.0000	7.0000	6.0000	20.0000	4.0000
175.0000	5.0000	15.0000	7.0000	20.0000	5.0000
175.0000	13.0000	13.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	181.6396	8.3604
120.0000	99.9170	20.0830
130.0000	145.0725	-15.0725
140.0000	136.7609	3.2391
150.0000	178.9140	-28.9140
75.0000	93.1167	-18.1167
100.0000	95.8307	4.1693
100.0000	126.8441	-26.8441
200.0000	169.9967	30.0033
50.0000	89.1200	-39.1200
175.0000	98.2020	76.7980
125.0000	97.8217	27.1783
200.0000	200.4585	-0.4585
50.0000	112.4369	-62.4369
175.0000	171.2550	3.7450
175.0000	157.6140	17.3860

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES.

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	18465.4512	5.0000	3693.0903	1.9532
ABOUT	18907.9863	10.0000	1890.7986	
TOTAL	37373.4380	15.0000		

PR (F > 1.9532) = 0.1720

COEFFICIENTS OF REGRESSION:

B(0) = -31.9606
B(1) = -0.5708
B(2) = 5.1714
B(3) = 12.1576
B(4) = 1.9974
B(5) = 4.7803

COEFFICIENT OF MULTIPLE CORRELATION = 0.7029
STANDARD ERROR OF THE ESTIMATE = 34.3766

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	20.0000	12.0000	7.0000	20.0000	6.0000
120.0000	12.0000	8.0000	5.0000	12.0000	4.0000
130.0000	10.0000	10.0000	6.0000	16.0000	5.0000
140.0000	12.0000	11.0000	6.0000	10.0000	4.0000
150.0000	23.0000	12.0000	8.0000	20.0000	7.0000
75.0000	10.0000	11.0000	3.0000	5.0000	3.0000
100.0000	12.0000	10.0000	5.0000	15.0000	4.0000
100.0000	21.0000	10.0000	7.0000	5.0000	5.0000
200.0000	20.0000	11.0000	7.0000	20.0000	7.0000
50.0000	5.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	7.0000	5.0000	15.0000	3.0000
125.0000	16.0000	7.0000	5.0000	15.0000	4.0000
200.0000	23.0000	12.0000	8.0000	22.0000	7.0000
50.0000	10.0000	7.0000	6.0000	20.0000	4.0000
175.0000	5.0000	10.0000	7.0000	20.0000	5.0000
175.0000	13.0000	8.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	172.4132	17.5868
120.0000	106.4389	13.5611
130.0000	142.8509	-12.8509
140.0000	130.1158	9.8842
150.0000	187.6387	-37.6387
75.0000	80.0173	-5.0173
100.0000	122.7739	-22.7739
100.0000	126.7581	-26.7581
200.0000	172.0221	27.9779
50.0000	82.1953	-32.1953
175.0000	104.7627	70.2373
125.0000	104.9766	20.0234
200.0000	191.6335	8.3665
50.0000	130.5461	-80.5461
175.0000	165.8521	9.1479
175.0000	134.0050	40.9950

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 2-3-4-5-6

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22665.1680	5.0000	4533.0337	3.0820
ABOUT	14708.2705	10.0000	1470.8270	
TOTAL	37373.4380	15.0000		

PR (F > 3.0820) = 0.0612

COEFFICIENTS OF REGRESSION:

B(0) = -16.0804
B(1) = 5.9207
B(2) = 9.1784
B(3) = -8.6055
B(4) = 3.4445
B(5) = 3.0376

COEFFICIENT OF MULTIPLE CORRELATION = 0.7787
STANDARD ERROR OF THE ESTIMATE = 30.3194

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	11.0000	16.0000	12.0000	7.0000	20.0000
120.0000	9.0000	10.0000	8.0000	5.0000	12.0000
130.0000	8.0000	14.0000	10.0000	6.0000	16.0000
140.0000	10.0000	15.0000	11.0000	6.0000	10.0000
150.0000	11.0000	15.0000	12.0000	8.0000	20.0000
75.0000	8.0000	14.0000	11.0000	3.0000	5.0000
100.0000	8.0000	8.0000	10.0000	5.0000	15.0000
100.0000	8.0000	15.0000	10.0000	7.0000	5.0000
200.0000	11.0000	15.0000	11.0000	7.0000	20.0000
50.0000	4.0000	6.0000	6.0000	3.0000	20.0000
175.0000	5.0000	8.0000	7.0000	5.0000	15.0000
125.0000	10.0000	8.0000	7.0000	5.0000	15.0000
200.0000	11.0000	17.0000	12.0000	8.0000	22.0000
50.0000	7.0000	7.0000	7.0000	6.0000	20.0000
175.0000	10.0000	15.0000	10.0000	7.0000	20.0000
175.0000	8.0000	13.0000	8.0000	6.0000	20.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.4998	12.5002
120.0000	113.8200	6.1800
130.0000	142.9970	-12.9970
140.0000	137.1859	2.8141
150.0000	171.7659	-21.7659
75.0000	90.6445	-15.6445
100.0000	81.4442	18.5558
100.0000	122.2066	-22.2066
200.0000	176.9269	23.0731
50.0000	82.1254	-32.1254
175.0000	89.4986	85.5014
125.0000	119.1021	5.8979
200.0000	196.1980	3.8020
50.0000	110.7940	-60.7940
175.0000	179.6117	-4.6117
175.0000	163.1798	11.8202

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 2-3-4-5-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	20213.5332	5.0000	4042.7065	2.3559
ABOUT	17159.9043	10.0000	1715.9905	
TOTAL	37373.4380	15.0000		

PR (F > 2.3559) = 0.1166

COEFFICIENTS OF REGRESSION:

B(0) = 35.4488
B(1) = 4.9063
B(2) = 7.7365
B(3) = -11.9611
B(4) = 5.2265
B(5) = 9.6794

COEFFICIENT OF MULTIPLE CORRELATION = 0.7354
STANDARD ERROR OF THE ESTIMATE = 32.7490

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	11.0000	16.0000	12.0000	7.0000	6.0000
120.0000	9.0000	10.0000	8.0000	5.0000	4.0000
130.0000	8.0000	14.0000	10.0000	6.0000	5.0000
140.0000	10.0000	15.0000	11.0000	6.0000	4.0000
150.0000	11.0000	15.0000	12.0000	8.0000	7.0000
75.0000	8.0000	14.0000	11.0000	3.0000	3.0000
100.0000	8.0000	8.0000	10.0000	5.0000	4.0000
100.0000	8.0000	15.0000	10.0000	7.0000	5.0000
200.0000	11.0000	15.0000	11.0000	7.0000	7.0000
50.0000	4.0000	6.0000	6.0000	3.0000	2.0000
175.0000	5.0000	8.0000	7.0000	5.0000	3.0000
125.0000	10.0000	8.0000	7.0000	5.0000	4.0000
200.0000	11.0000	17.0000	12.0000	8.0000	7.0000
50.0000	7.0000	7.0000	7.0000	6.0000	4.0000
175.0000	10.0000	15.0000	10.0000	7.0000	5.0000
175.0000	8.0000	13.0000	8.0000	6.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	164.3316	25.6684
120.0000	126.1324	-6.1324
130.0000	143.1559	-13.1559
140.0000	139.0645	0.9355
150.0000	171.5011	-21.5011
75.0000	96.1563	-21.1563
100.0000	81.8309	18.1691
100.0000	156.1189	-56.1189
200.0000	178.2356	21.7644
50.0000	64.7650	-14.7650
175.0000	93.3157	81.6843
125.0000	127.5267	-2.5267
200.0000	186.9741	13.0259
50.0000	110.2978	-60.2978
175.0000	165.9315	9.0685
175.0000	149.6621	25.3379

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 2-3-4-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22571.2539	5.0000	4514.2510	3.0497
ABOUT	14802.1846	10.0000	1480.2185	
TOTAL	37373.4380	15.0000		

PR (F > 3.0497) = 0.0629

COEFFICIENTS OF REGRESSION:

B(0) = -8.8632
B(1) = 6.0163
B(2) = 9.7094
B(3) = -9.4137
B(4) = 3.1364
B(5) = 2.5483

COEFFICIENT OF MULTIPLE CORRELATION = 0.7771
STANDARD ERROR OF THE ESTIMATE = 30.4161

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	11.0000	16.0000	12.0000	20.0000	6.0000
120.0000	9.0000	10.0000	8.0000	12.0000	4.0000
130.0000	8.0000	14.0000	10.0000	16.0000	5.0000
140.0000	10.0000	15.0000	11.0000	10.0000	4.0000
150.0000	11.0000	15.0000	12.0000	20.0000	7.0000
75.0000	8.0000	14.0000	11.0000	5.0000	3.0000
100.0000	8.0000	8.0000	10.0000	15.0000	4.0000
100.0000	8.0000	15.0000	10.0000	5.0000	5.0000
200.0000	11.0000	15.0000	11.0000	20.0000	7.0000
50.0000	4.0000	6.0000	6.0000	20.0000	2.0000
175.0000	5.0000	8.0000	7.0000	15.0000	3.0000
125.0000	10.0000	8.0000	7.0000	15.0000	4.0000
200.0000	11.0000	17.0000	12.0000	22.0000	7.0000
50.0000	7.0000	7.0000	7.0000	20.0000	4.0000
175.0000	10.0000	15.0000	10.0000	20.0000	5.0000
175.0000	8.0000	13.0000	8.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	177.7223	12.2777
120.0000	114.8995	5.1005
130.0000	143.9876	-13.9876
140.0000	134.9491	5.0509
150.0000	170.5612	-20.5612
75.0000	94.9764	-19.9764
100.0000	80.0462	19.9538
100.0000	119.1962	-19.1962
200.0000	179.9749	20.0251
50.0000	84.8022	-34.8022
175.0000	87.6899	87.3101
125.0000	120.3199	4.6801
200.0000	196.2529	3.7471
50.0000	108.2436	-58.2436
175.0000	178.2755	-3.2755
175.0000	163.1030	11.8970

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 2-3-5-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22017.3945	5.0000	4403.4790	2.8676
ABOUT	15356.0439	10.0000	1535.6044	
TOTAL	37373.4380	15.0000		

PR (F > 2.8676) = 0.0735

COEFFICIENTS OF REGRESSION:

B(0) = -58.0053
B(1) = 5.5276
B(2) = 6.3894
B(3) = 8.6437
B(4) = 3.4969
B(5) = -8.6731

COEFFICIENT OF MULTIPLE CORRELATION = 0.7675
STANDARD ERROR OF THE ESTIMATE = 30.9799

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	11.0000	16.0000	7.0000	20.0000	6.0000
120.0000	9.0000	10.0000	5.0000	12.0000	4.0000
130.0000	8.0000	14.0000	6.0000	16.0000	5.0000
140.0000	10.0000	15.0000	6.0000	10.0000	4.0000
150.0000	11.0000	15.0000	8.0000	20.0000	7.0000
75.0000	8.0000	14.0000	3.0000	5.0000	3.0000
100.0000	8.0000	8.0000	5.0000	15.0000	4.0000
100.0000	8.0000	15.0000	7.0000	5.0000	5.0000
200.0000	11.0000	15.0000	7.0000	20.0000	7.0000
50.0000	4.0000	6.0000	3.0000	20.0000	2.0000
175.0000	5.0000	8.0000	5.0000	15.0000	3.0000
125.0000	10.0000	8.0000	5.0000	15.0000	4.0000
200.0000	11.0000	17.0000	8.0000	22.0000	7.0000
50.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	10.0000	15.0000	7.0000	20.0000	5.0000
175.0000	8.0000	13.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	183.4354	6.5646
120.0000	106.1269	13.8731
130.0000	140.1154	-10.1154
140.0000	145.2514	-5.2514
150.0000	177.0166	-27.0166
75.0000	93.0640	-18.0640
100.0000	98.3113	1.6887
100.0000	116.6822	-16.6822
200.0000	168.3729	31.6271
50.0000	80.9655	-30.9655
175.0000	90.4016	84.5984
125.0000	109.3665	15.6335
200.0000	196.7894	3.2106
50.0000	112.5227	-62.5227
175.0000	180.1915	-5.1915
175.0000	156.3869	18.6131

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 2-4-5-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	22017.3945	5.0000	4403.4790	2.8676
ABOUT	15356.0439	10.0000	1535.6044	
TOTAL	37373.4380	15.0000		

PR (F > 2.8676) = 0.0735

COEFFICIENTS OF REGRESSION:

B(0) = -58.0053
B(1) = 5.5276
B(2) = 6.3894
B(3) = 8.6437
B(4) = 3.4969
B(5) = -8.6731

COEFFICIENT OF MULTIPLE CORRELATION = 0.7675
STANDARD ERROR OF THE ESTIMATE = 30.9799

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	11.0000	16.0000	7.0000	20.0000	6.0000
120.0000	9.0000	10.0000	5.0000	12.0000	4.0000
130.0000	8.0000	14.0000	6.0000	16.0000	5.0000
140.0000	10.0000	15.0000	6.0000	10.0000	4.0000
150.0000	11.0000	15.0000	8.0000	20.0000	7.0000
75.0000	8.0000	14.0000	3.0000	5.0000	3.0000
100.0000	8.0000	8.0000	5.0000	15.0000	4.0000
100.0000	8.0000	15.0000	7.0000	5.0000	5.0000
200.0000	11.0000	15.0000	7.0000	20.0000	7.0000
50.0000	4.0000	6.0000	3.0000	20.0000	2.0000
175.0000	5.0000	8.0000	5.0000	15.0000	3.0000
125.0000	10.0000	8.0000	5.0000	15.0000	4.0000
200.0000	11.0000	17.0000	8.0000	22.0000	7.0000
50.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	10.0000	15.0000	7.0000	20.0000	5.0000
175.0000	8.0000	13.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	183.4354	6.5646
120.0000	106.1269	13.8731
130.0000	140.1154	-10.1154
140.0000	145.2514	-5.2514
150.0000	177.0166	-27.0166
75.0000	93.0640	-18.0640
100.0000	98.3113	1.6887
100.0000	116.6822	-16.6822
200.0000	168.3729	31.6271
50.0000	80.9655	-30.9655
175.0000	90.4016	84.5984
125.0000	109.3665	15.6335
200.0000	196.7894	3.2106
50.0000	112.5227	-62.5227
175.0000	180.1915	-5.1915
175.0000	156.3869	18.6131

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.

REGRESSION ANALYSIS OF VARIANCE WITH 5 INDEPENDENT VARIABLES. 3-4-5-6-7

SOURCE	SSQ	D.F.	MSQ	FCALC
DUE TO	21957.4766	5.0000	4391.4951	2.8487
ABOUT	15415.9619	10.0000	1541.5962	
TOTAL	37373.4380	15.0000		

PR (F > 2.8487) = 0.0747

COEFFICIENTS OF REGRESSION:

B(0) = -2.7524
B(1) = 9.5166
B(2) = -7.1838
B(3) = 3.4108
B(4) = 2.9206
B(5) = 4.8696

COEFFICIENT OF MULTIPLE CORRELATION = 0.7665
STANDARD ERROR OF THE ESTIMATE = 31.0403

Y	X(1)	X(2)	X(3)	X(4)	X(5)
190.0000	16.0000	12.0000	7.0000	20.0000	6.0000
120.0000	10.0000	8.0000	5.0000	12.0000	4.0000
130.0000	14.0000	10.0000	6.0000	16.0000	5.0000
140.0000	15.0000	11.0000	6.0000	10.0000	4.0000
150.0000	15.0000	12.0000	8.0000	20.0000	7.0000
75.0000	14.0000	11.0000	3.0000	5.0000	3.0000
100.0000	8.0000	10.0000	5.0000	15.0000	4.0000
100.0000	15.0000	10.0000	7.0000	5.0000	5.0000
200.0000	15.0000	11.0000	7.0000	20.0000	7.0000
50.0000	6.0000	6.0000	3.0000	20.0000	2.0000
175.0000	8.0000	7.0000	5.0000	15.0000	3.0000
125.0000	8.0000	7.0000	5.0000	15.0000	4.0000
200.0000	17.0000	12.0000	8.0000	22.0000	7.0000
50.0000	7.0000	7.0000	6.0000	20.0000	4.0000
175.0000	15.0000	10.0000	7.0000	20.0000	5.0000
175.0000	13.0000	8.0000	6.0000	20.0000	4.0000

TABLE OF RESIDUALS:

Y	YC	R=Y-YC
190.0000	174.8131	15.1869
120.0000	106.5230	13.4770
130.0000	150.1846	-20.1846
140.0000	130.1241	9.8759
150.0000	173.5769	-23.5769
75.0000	90.9023	-15.9023
100.0000	81.8841	18.1159
100.0000	130.9852	-30.9852
200.0000	177.3499	22.6501
50.0000	89.6284	-39.6284
175.0000	98.5659	76.4341
125.0000	103.4355	21.5645
200.0000	198.4513	1.5487
50.0000	111.9328	-61.9328
175.0000	174.7945	0.2055
175.0000	161.8485	13.1515

DataFiles for YC.DAT AND R.DAT have been created.
Use with SCATPLOT to view behavior of residuals.