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"Attrition" in Information Dissemination
Relationships with Industry

Submitted in Partial Fulfillment of
Requirements for Contract
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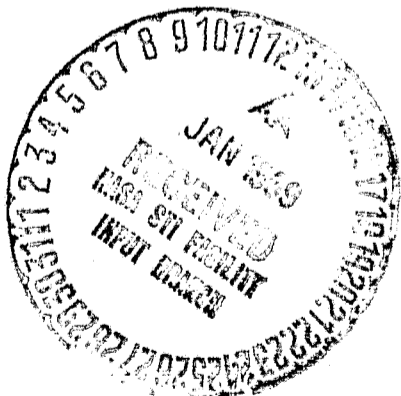
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I. ABSTRACT

A study of large and small industries that have received service from the University of Pittsburgh - NASA Regional Dissemination Center (KASC) was conducted in an attempt to identify factors which influence these industries to continue or discontinue relationships with the activity. Fifty-one hypotheses were tested statistically in relation to 40 questions that were posed in connection with this study. Only eight hypotheses were supported significantly by statistical evidence and, of these, three are considered interesting. Industries that have continued relationships with the activity have: (1) provided more feedback information to the KASC than those industries that have discontinued; (2) received a higher proportion of relevant responses than those industries that have discontinued the relationship; and (3) had administrative staff of the company negotiate the initial contract in lieu of corporate officers. Unexpectedly, hypotheses relating to the positive effect on contract renewal of frequent contacts, as opposed to impersonal feedback contacts on a periodic basis, were not supported by statistical evidence.

II. Purpose

A study has been conducted in relation to two contractual requirements, as follows:

(1) "The Contractor shall use its best efforts to study and analyze the attrition of any fee-paying industrial client companies which previously subscribed to the services offered by the Contractor's Regional Dissemination Center.

"An objective of this study is to determine means of better orienting services offered to current and prospective clients."

(2) "The Contractor shall for the remaining duration of the one-year small business program conducted in conjunction with the Small Business Administration and the National Aeronautics and Space Administration provide support and services to the six selected small businesses. The Contractor shall further study the rationale of these companies underlying acceptance or rejection of subsequent fee-paying membership.

"An objective of this study is to determine suitability of Regional Dissemination Center services for small business organizations."

The two requirements have as common purposes the identification of those factors that would:(1) influence the development of long term relationships with industries served by the Knowledge Availability Systems Center (KASC); and (2) permit solicitation of those industries which have the greatest likelihood of benefiting from the services offered. Accordingly, the two contractual requirements have been considered together in connection with this study.

III. Definitions

"A" Document

"A" documents are those reported in the journal, International Aerospace Abstracts, and whose index entries are matched against strategies for current questions in the KASC/NASA Technology Utilization Program.

Abstract Evaluation Forms

Abstract evaluation forms are forms attached to forwarded abstracts to be used by requesters for evaluation of the abstracts (i.e., whether or not the abstract is relevant; non-relevant but of some interest to the company); and, also, for the purpose of ordering the complete document.

Active Company

An active company is a company currently subscribing to the KASC/NASA Technology Utilization Program on a regular fee-paying basis.

Attrition Company

An attrition company is a company that had subscribed to the KASC/NASA Technology Utilization Program on a regular fee-paying basis but, for various reasons, did not renew its contract between April 1965 and December 31, 1967.

"Bad" Questions

A "bad" question is a question considered by the Engineering consultant or Center analyst to be one that has little chance of retrieving information from the system. That is, the question may not be matched correctly to the KASC/NASA file, with the result that the requester is forwarded abstracts not relevant to his particular interests.

Center Analyst

A Center analyst is a technically oriented individual, employed by the KASC, who is responsible for monthly review of data from the KASC/NASA Technology Utilization Program for assigned company questions.

Comparison Company

A comparison company is a company selected from the list of active companies, on the basis of the number of questions they have in service (3, 4, 6, and 7), for comparison against the SBA companies.

Engineering Consultant

An Engineering consultant is a faculty member from the University of Pittsburgh, School of Engineering, who actively participates in the formulation of new questions and their strategies for companies. Also, he reviews retrospective output and monthly data for current awareness questions in the KASC/NASA Technology Utilization Program.

Files

The files are search tapes consisting of retrospective and current awareness magnetic tapes compiled from the literature appearing in Scientific and Technical Aerospace Reports and International Aerospace Abstracts, and it is searched monthly by KASC to service active participating companies.

Forwarded (or Sent) Abstracts

Forwarded abstracts are retrieved abstracts which have been reviewed by a Center analyst or Engineering consultant for relevancy and are considered to be relevant to a company's request, and, therefore, forwarded for a search period.

Large Company

A large company is defined as having 500 or more employees.

"N" Document

"N" documents are those reported in the journal, Scientific
and Technical Aerospace Reports, and whose index entries
are matched against strategies for current questions in the
KASC/NASA Technology Utilization Program.

"Noise"

"Noise" is defined as document numbers cited by a computer search
as potentially relevant to a particular question's search strategy
but which are later determined to be non-relevant to the particu-
lar interests of a requester.

Other (Unidentified) Interests

Other (unidentified) interests are interests not revealed by the
user's query but are indicated on evaluation forms by the user
as being of some interest to him.

Retrieved Abstracts

Retrieved abstracts are abstracts which correspond to document
numbers that have been cited by a computer search as potentially
relevant to a particular question's search strategy.

Reviewer

A reviewer is a KASC staff member responsible for monthly re-
view of data from the KASC/NASA Technology Utilization Program
file and can be an Engineering consultant or Center analyst.

SBA Company

A SBA (Small Business Administration) company was one of six
companies serviced for a one-year period, March 1966 to March
1967, under a program sponsored by NASA in conjunction with SBA.

Search Period

A search period covers two issues of Scientific and Technical
Aerospace Reports and International Aerospace Abstracts.

SIC Code

An SIC (Standard Industrial Classification) code is used to
define the broad scope of a company's industrial interests
and activities.*

Small Company

A small company is defined as having 499 or fewer employees.

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* Bureau of the Budget, Office of Statistical Standards; Prepared by
The Technical Committee on Industrial Classification; Standard
Industrial Classification Manual, Washington 25, D.C., U.S. Govern-
ment Printing Office, 1957.

IV. Sampling Procedures and Data Collection

Sampling Procedures

Companies: The population was defined as those companies served by the KASC, University of Pittsburgh, from May 1964 to December 31, 1967. The population lent itself to division into two main groups: attrition companies and active (control) companies. From these groups 62 companies (32 attrition and 30 active) were selected, and comprised the final sample.

The selected companies in both groups (attrition and active) were divided by company size, into large or small. This was done to identify those companies, both attrition and active, that would compare to the SBA companies in both groups; and, also, to provide overall attrition comparison data.

Questions: All questions posed from May 1964 to December 31, 1967 by any of the companies in the final sample were used for data collection purposes.

For surveying the Engineering consultants and Center analysts, three questions were randomly selected from each company's set of questions.

Data Collection

Data identified as having potential significance were obtained from three sources: (1) external references; (2) KASC files; and (3) Engineering consultants and Center analysts.

External References: From available references, data were collected concerning the companies' history (i.e., date and place of incorporation, rank, etc.), ownership (i.e., number of shares of stock outstanding, number of stockholders, etc.), financial information (i.e., capital, gross revenues, etc.), material holdings (i.e., subsidiaries, plants and properties, etc.), personnel, and products.

Information was also collected concerning geographic location of the company, Standard Industrial Classification (SIC) code of the company, and whether the company held a NASA prime contract or subcontract.

KASC files: The internal files of KASC provided the greatest portion of the collected data. Primary data were collected in terms of the individual questions submitted by the companies for each search period, and included: (1) the number of documents cited by the computer as potentially relevant to the question; (2) the number of documents cited for which abstracts are forwarded to the user, after review by an Engineering consultant or Center analyst; (3) feedback information from the user as to potential relevancy of the abstracts, and (4) requester orders for documents (i.e., either hard copy or microfiche of the entire text).

Engineering consultants and Center analysts: From two questionnaires, data were collected on the Engineering consultants' overall evaluation of the company as a KASC service participant (i.e., obtaining useful information from the file, relevancy of information, etc.), and the Engineering consultants' and Center analysts' evaluation of specific company questions submitted to the KASC system (i.e., file service, relevance of forwarded abstracts, etc.).

V. Questions, Hypotheses, and Analysis of Data

Forty questions have been posed which were considered to be relevant to the study; and 51 hypotheses relating to these questions were formulated. Data were collected and analyzed statistically to test each hypothesis.

The questions fall into several categories, relating to the:

(a) effect of the company size, location, and product lines;

(b) effect of the quantity, quality, and type of service provided by the KASC to companies;

(c) effect of the nature of industry problems addressed to the KASC service;

(d) effect of the extent of company cooperation in providing feedback to KASC;

(e) effect of the level, quantity, and quality of personal contacts between KASC staff and company personnel;

(f) effect of the ability of KASC staff to predict probability of successful service;

(g) effect of miscellaneous factors.

The specific questions posed and the related hypotheses and analysis are:

(a) Effect of the Company Size, Location, and Product Lines:

Question 1	Related Hypothesis
Do more large companies than small companies tend to remain active participants in the system?	1. There is a significantly higher proportion of large companies than small companies that remain active in the system.

Statistical evidence does not warrant accepting this hypothesis at the .05 level of confidence. Although a large proportion of small companies do attrition, there is not a corresponding high proportion of large companies that remain active. Even though the differences are not significant, the coefficient of contingency (C = .17) and the correlation coefficient (r = .18) indicate that there is some statistical association between the attributes. Companies that remain active do tend to be large companies.

Question 2	Related Hypothesis
After an Engineering consultant has been in contact with a company and gains some insight into the kinds of information the company needs, can he predict whether or not the large company's questions tend to have better prospects of retrieving information from the file than the small company's questions?	1. In the opinion of the Engineering consultant, the prospects of retrieving relevant information are better for questions from the large company than from the small company.

The value of X^2 indicates that there is very little difference between the proportion of questions submitted by the large companies that are considered good prospects and the proportion from small companies. The hypothesis is rejected with a probability between .50 and .75 of being right. The measures of association (C = .04, r = .04) indicate almost no relationship between the size of the company and the prospects of the question.

The index of predictive association $(\lambda_B = 0)$ indicates that even by knowing the Engineering consultant's opinion of the question, the probability of correctly predicting whether the question comes from a large or small company is not reduced by any amount. The Engineering consultant's opinion on the question's prospect is not useful information (i.e., it does not reduce the probability of being wrong).

Question 3

Are there any differences in the Engineering consultant's overall impression of the abstracts provided with respect to specific questions that differentiate between large and small companies? Do large companies receive a "different" set of abstracts (i.e., significantly different along several hypothesized dimensions) than do small companies?

Related Hypotheses

1. In the opinion of the Engineering consultant with respect to the questions he reviews, more of the abstracts forwarded in response to the questions of large companies are relevant to the questions than the abstracts forwarded to small companies.

We reject this hypothesis and conclude that there is no statistical difference between the abstracts forwarded to the large companies and those forwarded to small companies. Statistical association is almost zero for these attributes, while predictive association is zero. More abstracts for both large and small companies are catagorized as low in the degree of relatedness to the questions than for any other category. The zero value of predictive association suggests that the observed values for each of these categories does not deviate greatly from the expected values.

2. In the opinion of the Engineering consultant on the specific questions he reviews, more of the abstracts forwarded, as a whole, to the large companies are a full review of the literature than the sets of abstracts forwarded to the small companies.

The value of x^2 refutes this hypothesis since the differences between the large and small companies with respect to the abstracts being representative of the literature in the file is not large enough to be significant. Again, the zero value of the coefficient of predictive association is indicative of the lack of differences between the expected values and the observed values for each category. The coefficients of association are almost zero (C = .05, $\dot{r}$ = .05) indicating little relationship between the attribute of representativeness and company size.

3. In the opinion of the Engineering
   consultant on the specific questions
   he reviews, more of the abstracts
   forwarded to the large companies
   reflect a representative sampling
   of the literature compared to the
   abstracts forwarded to the small
   companies.

We reject this hypothesis and conclude that the proportion of abstracts that
are a representative sampling of the literature is not significantly greater
for large companies than for small companies. Although the X^2 value of
1.33 indicates some differences, these are not nearly large enough to be
significant. The coefficients of association are low (C = .12, r = .13). The
coefficient of predictive association is zero.

The next series of questions is about the service provided to the two
groups of companies (large vs. small) by the KASC. The objective is to determine
if there are differences in the types of questions asked by the large companies
vs. the type asked by the small companies which differentiate the service
provided to the two groups. Hypotheses are again formulated from the questions
and tested statistically for evidence as to their acceptability.

Question 4	Related Hypothesis
Are there any differences between the large and small companies in their willingness to cooperate with the KASC in improving the service? Are the large companies more cooperative than the small companies?	1. The large companies are more cooperative (i.e., the proportion of abstract evaluation forms returned to the KASC by large companies is significantly greater than the proportion of forms returned by small companies).

The evidence supports the hypothesis that the proportion of abstract
evaluation forms returned to the KASC by large companies is significantly
higher than the proportion returned by small companies. The level of confidence
for failing to reject this hypothesis is less than .001.

Question 5	Related Hypothesis
Are there any differences between the types of questions asked by the two groups of companies that may account for the large companies being forwarded a higher proportion of abstracts from the search output than the small companies?	1. The large companies submit questions which have a higher probability of finding potentially relevant information in the file (i.e., the proportion of retrieved abstracts forwarded as potentially relevant to large companies is significantly higher than the proportion forwarded to small companies).

Evidence does not support the hypothesis. On both retrospective and current awareness searches, the proportion of retrieved abstracts that is forwarded to the small companies is greater than the proportion forwarded to large companies.

The probability of making an error in rejecting the hypothesis for either case is less than .005.

Question 6	Related Hypothesis
Do requesters from large companies find a greater proportion of the search output forwarded to them to be relevant to their information needs than requesters from small companies?	1. Requesters from large companies evaluate a larger proportion of the search output forwarded to them as relevant to their information needs than requesters from small companies.

Statistical evidence does not support the hypothesis for either retrospective or current awareness searches with a probability of being incorrect of less than .005. Small companies evaluate a larger proportion of the abstracts forwarded to them as relevant to their information needs than do the large companies.

Question 7	Related Hypothesis
Are there differences in the types of questions asked by the two groups such that the large companies are less likely to be satisfied with the abstracts forwarded to them than are small companies?	1. Large companies evaluate a larger proportion of the search output forwarded to them as non-relevant to their needs than small companies.

There is no evidence to reject the hypothesis in either case. We conclude, that large companies do find a significantly greater proportion of the output non-relevant to their needs than do small companies. It seems that the smaller companies ask more questions that are related to their specific needs than do the larger companies.

Question 8	Related Hypothesis
Do requesters from large companies find a greater proportion of the abstracts forwarded to them to be related to their other (unidentified) interests as compared to requesters from small companies?	1. Requesters from large companies find a greater proportion of abstracts forwarded to them to be related to their other (unidentified) interests than requesters from small companies.

The hypothesis is supported by the statistical evidence to a degree greater than the .05 confidence level. We conclude that large companies evaluate a larger proportion of forwarded abstracts as related to their other (unidentified) interests than do small companies.

Question 9	Related Hypothesis
Do large companies order more documents in either hard copy or microfiche than do small companies?	1. Requesters from large companies order a significantly greater proportion of the search output forwarded to them in either hard copy or microfiche than do requesters from small companies.

The hypothesis is rejected in the case of retrospective searches but not in the case of current awareness searches. Large companies do not order significantly more hard copy or microfiche than small companies on retrospective searches, but do order significantly more on current awareness searches.

Question 10	Related Hypothesis
Is company size related to distance from the KASC? Are large companies more willing to maintain less personalized communication links with KASC?	1. There is a significant difference between the large and small companies in their respective distances from KASC.

The hypothesis is rejected with 90% confidence that there are no significant differences between the attributes of distance from the KASC and company size. The distribution of small companies is very similar to the distribution of large companies with respect to distance. The low values of the contingency coefficient (.10) and correlation coefficient (.06) also reflect a lack of statistical association. λ_B is zero indicating there is no reduction in the amount of uncertainty in predicting one attribute given information about the other.

Question 11

Is the distance from KASC (University of Pittsburgh), in statute miles, a factor in whether or not a company tends to remain in the system?

Related Hypothesis

1. There are significant differences between the attrition companies and the active companies in their respective distances from KASC.

The 2.27 value of x^2 with 4 df (degrees of freedom) is not large enough to accept the hypothesis that there are significant differences between attrition and active companies with respect to distance from the KASC.

The attribute of distance is only slightly associated with company status as reflected in the coefficient of contingency (.19) and the correlation coefficient (.10).

The index of predictive association indicates that by knowing the distance of a company from the KASC one could reduce the uncertainty as to company status by only 3%.

Question 12

Do large companies in the system ask more questions directly related to products/processes with which they are concerned than do small companies?

Related Hypothesis

1. The proportion of questions asked by large companies directly related to their SIC code(s) is significantly greater than the proportion related to the SIC code(s) of small companies.

We reject this hypothesis and conclude that there are no significant differences between the large and small companies with respect to the relatedness of the questions to the companies' SIC code(s). With samples of this size, and a x^2 value of .55, the probability of there being no significant difference in the populations is between .25 and .50. The attribute of question relatedness is associated with company size to a very small degree (C = .08, r = .09). The coefficient of predictive association is zero so that knowing company size will not reduce the probability of being wrong in predicting the relatedness of the question to the company's SIC code(s).

Question 13

Do companies that remain in the system ask more questions directly related to the processing of the company's marketable product(s) than do attrition companies?

Related Hypothesis

1. The companies that remain active in the system ask more questions directly related to their SIC code(s) than do attrition companies.

The low value of χ^2 (.221) is evidence for rejecting the hypothesis and concluding that there are no significant differences between the attrition companies and the active companies with respect to the correspondence between the company's question and its SIC code(s). There is almost no statistical association between the correspondence of the questions to the companies' SIC code(s) and the status of the companies. The lack of significant differences is also reflected in the zero value for the coefficient of predictive association. Knowing the relationship of the question to the company's SIC code(s) does not reduce (by any amount) the probability of being wrong in predicting whether or not a company remains active.

Question 14

Are there differences between the positions held in the company by the contract negotiators that may be related to company size?

Related Hypothesis

1. More contract negotiators from small companies are officers of the company, while for large companies they tend to be department administrators.

The very large value of χ^2 (25.86) is evidence that there are significant differences between the large and small companies relative to the positions held by individuals with whom company negotiations are conducted. Contract negotiators from large companies are, generally, lower level decision-making personnel in the company hierarchy, while for small companies almost all the negotiators are company officers.

The confidence level for significant differences as large as these appearing in the population is .005.

The coefficient of contingency (.54) and the correlation coefficient (.29) indicate some systematic relationship between the two attributes. The index of predictive association is .50 which means that by knowing the value of one attribute, the probability of error in predicting the second is reduced by 50%.

Question 15

Are there differences in the size of the contracts held with the KASC that may be related to company size?

Related Hypothesis

1. Large companies commit themselves to large literature searching contracts with the KASC while small companies prefer small or modest contracts.

The value of x^2 is very large indicating that there are very significant differences between large and small companies with respect to the size of the contract (in dollars per year). Probability that we are wrong in asserting that these differences exist in the population is very small ($p < .001$). There is a fairly good degree of association between the attributes (value of the contract vs. company size) and also a fairly high degree of predictive association ($\lambda_B = .32$).

Large companies negotiated large contracts while small companies committed themselves to more modest and smaller contracts.

Question 16

Does the size of the company have any association with a KASC - serviced company being a prime contractor or subcontractor with NASA?

Related Hypothesis

1. More large companies serviced by the KASC have NASA contracts and subcontracts than do small companies.

The value of x^2 is large, but not large enough to indicate significant differences between large and small companies with respect to their holding NASA prime contracts or subcontracts at the .05 level of confidence. About 44% of the large companies hold NASA contracts while only 26% of the small companies hold them.

The attribute "holding a NASA contract or subcontract" is associated only .17 with company size. The index of predictive association is zero indicating that prediction cannot be improved given information about whether or not a company holds a NASA contract or subcontract.

Question 17	Related Hypothesis
Does the size of the company have any relationship to the type of contract (NASA prime contract or subcontract) awarded companies serviced by KASC?	1. There are more large companies than small companies serviced by the KASC having prime contracts rather than subcontracts with NASA (i.e., large companies tend to have prime contracts while small companies have subcontracts).

Based on the statistical evidence, the hypothesis must be rejected and the conclusion drawn that there are no significant differences at the .05 level of confidence.

Even though more large companies have prime contracts and small companies tend toward subcontracts, these differences are not statistically significant. The attributes of contract type and company size are associated to a low degree (C = .12, r = .13). The index of predictive association is zero, indicating that it is not useful information in making predictions to know the type of NASA contract held by KASC serviced companies.

(b) Effect of the Quantity, Quality, and Type of Service Provided by the KASC to Companies:

Question 18	Related Hypotheses
Is there any difference in the output product (abstracts) provided to satisfy company needs which differentiates between companies that tend to remain active and those that attrition?	1. In the opinion of the Center analyst or Engineering consultant, abstracts sent to companies which remain active are related to all of their questions, generally, to a greater degree than the abstracts sent to attrition companies.

This hypothesis cannot be accepted. There is no significant association between the Center analysts' or Engineering consultants' opinion of the relationship of the abstracts to the questions and a company's status in the system. The coefficient of contingency and the correlation coefficient are almost zero. The proportion of times the set of abstracts are really related to the questions is nearly the same for attrition companies as it is for companies which remain active.

2. In the opinion of the Center analyst or Engineering consultant, abstracts forwarded to active companies represent a full review of the literature relating to all of their questions, generally, a greater proportion of the time than the abstracts sent to attrition companies.

The evidence is contrary to the hypothesis. Whether a company remains active or not is not statistically dependent upon the abstracts forwarded to the company being a full review of the literature. The Center analysts or Engineering consultants feel that roughly 3 out of 5 sets of abstracts forwarded to users are not full reviews of the literature. Of those sets of abstracts that are considered full reviews of the literature, they are divided between active companies and attrition companies in roughly the same proportion.

The coefficient of contingency being .02 and the correlation of attributes, also .02, reflect a low degree of association between ! representativeness of the abstracts and the company's willingness to remain in the system.

3. In the opinion of the Center analyst or Engineering consultant, abstracts sent to active companies represent a good sa oling of the literature relatin to all of their questions, generally, more frequently than the abstracts forwarded to attrition companies.

There is no statistical difference between the abstracts sent to companies that remain active and the companies that attrition in relation to their representing a good sampling of the literature.

The Center analysts or Engineering consultants feel that about 3 out of 5 sets of abstracts forwarded to the companies represented a good sampling of the literature and these are distributed between the active and attrition companies in roughly the same proportion.

There is no correlation between the representativeness of the literature and company status. Both the contingency coefficient and correlation coefficient are zero.

Question 19	Related Hypotheses
Are there any differences in the Engineering consultant's or Center analyst's overall impression of the abstracts provided for specific questions that differentiate between active and attrition companies?	1. In the opinion of the Engineering consultant or Center analyst, with respect to questions he reviews, more of the abstracts forwarded to active companies relate to their corresponding questions than do abstracts forwarded to attrition companies.

We reject this hypothesis and conclude that there is no statistical difference between the two groups of companies with regard to the relatedness of the abstracts to specific questions. Statistical association between the attributes is low (coefficient of contingency and correlation are .21 and .13 respectively).

More abstracts for both the active and the attrition companies are categorized as low in the degree of relationship to their questions than any other category. However, the observed values for each of these categories does not deviate greatly from the expected values. This is reflected in the low value of the coefficient of predictive association which is .03. Knowing the Engineering consultant's or Center analyst's opinion on the degree of relationship between the abstracts and their questions reduces the probability of being wrong only 3 percent.

2. In the opinion of the Engineering consultant or Center analyst, for the specific questions he reviews, more of the abstracts forwarded to active companies are representative of the literature for their respective questions than the abstracts forwarded to attrition companies.

The value of X^2 (.27) refutes this hypothesis since the differences between active and attrition companies with respect to the abstracts being representative of the literature in the file are not large enough to be significant. Most of the observed values for each category are close to the expected values except in category 1 - "a complete review of the literature." Here the attrition companies have fewer than expected while the active companies have more than expected.

The coefficients of relationship or association are low (C = .23, r = .14) indicating little relationship between the attribute of representativeness and company status. The coefficient of predictive association is .10 indicating that one does not do a great deal better predicting company status with the Engineering consultants' or Center analysts' opinion of the abstracts for a question than without it.

> 3. In the opinion of the Engineering consultant or Center analyst, on the specific questions he reviews, more of the abstracts forwarded to active companies reflect a representative sampling of the literature than the abstracts forwarded to attrition companies.

We reject the hypothesis that on these specific questions active companies receive a larger proportion of abstracts that are a good sampling of the literature compared to the abstracts forwarded to attrition companies. Although the differences are large, they are not significant at the acceptable, predetermined .05 level.

A larger proportion of active companies have questions which retrieve a more representative sampling of the literature than do questions submitted by attrition companies. The attrition companies have fewer questions for which the abstracts are a representative sampling than expected, while the active companies have more than expected.

The attribute of representativeness has a contingency coefficient of .26 and a correlation coefficient of .16 with company status. The coefficient of predictive association is zero (due to the lack of differences between observed and expected values) meaning that knowing the Engineering consultant's or Center analyst's opinion on the abstracts in relation to their being a representative sampling of the literature does not reduce the probability of being wrong in predicting the company's status.

The remaining questions in this section are about the service provided by the KASC to the companies and about the information in the data base. Hypotheses

are, again, formulated from the questions and tested statistically for evidence

as to the acceptability of the various hypotheses.

Question 20	Related Hypothesis
Do companies that remain active do so because they get relevant answers to their questions to a greater degree than attrition companies?	1. Companies that remain active are more likely to be satisfied with the abstracts forwarded to them than are attrition companies. That is, the proportion of forwarded abstracts judged potentially relevant by active companies is greater than the proportion judged potentially relevant by attrition companies.

We reject this hypothesis in the case of retrospective searches. The

opposite is true - the attrition companies have a significantly higher

proportion of forwarded abstracts judged relevant than do the active companies.

The probability of being wrong in rejecting this hypothesis for retrospective

searches is .002.

We do not reject the hypothesis in the case of current awareness searches

with a probability of being wrong of less than .001. The active companies

do receive a significantly greater proportion of potentially relevant

abstracts than the attrition companies on the current awareness basis.

Question 21	Related Hypothesis
Do attrition companies discontinue service because there is too much non-relevant information in the abstracts forwarded to them? To a greater degree than active companies?	1. Attrition companies find more "noise" (i.e., non-relevant, non-useful information) in the search output than do active companies. That is, attrition companies find a greater proportion of forwarded abstracts non-relevant to their request than do companies that remain active.

There is no evidence to refute this hypothesis for either retrospective or

current-awareness searches. The probability of being wrong in rejecting this

hypothesis in either case is less .001. The attrition companies do re-

ceive significantly more "noise" than active companies.

Question 22	Related Hypothesis
Do companies which remain active not only find relevant information in the file, but also information tangentially related to their other (unidentified) interests? To a greater degree than attrition companies?	1. Active companies find more abstracts potentially related to their other (unidentified) interests than do attrition companies. That is, active companies find a greater proportion of forwarded abstracts that relate to their other (unidentified) interests than do attrition companies.

The hypothesis must be rejected for both cases (i.e., current awareness and retrospective searches). Again the antithesis is true, the attrition companies found a significantly greater proportion of the abstracts forwarded to them to be related to their other (unidentified) interests than did the active companies. The probability of being wrong - less than .001.

Question 23	Related Hypothesis
Do active companies use the remaining part of the KASC service (i.e., reproduction of the potentially relevant documents in microfiche or hard copy) more frequently than do attrition companies?	1. Active companies order a greater proportion of documents in hard copy or microfiche than do attrition companies.

We reject the hypothesis in the case of retrospective searches. Attrition companies order a significantly larger proportion of documents in hard copy or microfiche. The probability of being wrong in rejecting this hypothesis and accepting the alternative is approximately .005.

The hypothesis cannot be rejected on the current awareness search basis. Active companies do order more hard copy or microfiche for these searches than do attrition companies. Probability of being wrong in not rejecting this hypothesis for this case is less than .001.

Question 24

Are there any differences in document or abstract service from the "A" and "N" portions of the NASA file such that a significant difference in the proportion of one type or the other in the search results may influence the companies in their decision about remaining in the system?

Related Hypotheses

1. Significantly more "A" abstracts than "N" abstracts are retrieved for companies that remain in the system than for attrition companies.

2. Significantly more "A" abstracts than "N" abstracts are forwarded as potentially relevant for companies that remain in the system than for attrition companies.

3. Significantly more "A" abstracts than "N" abstracts are forwarded as potentially relevant, and subsequently judged relevant, to companies that remain active than those that are forwarded, and subsequently judged relevant, to attrition companies.

4. Significantly more "A" abstracts than "N" abstracts are forwarded as potentially relevant, and subsequently judged non-relevant, to companies that remain active than those that are forwarded, and subsequently judged non-relevant, to attrition companies.

5. Significantly more "A" documents are ordered (i.e., hard copy or microfiche) by active companies than are ordered by attrition companies.

All five of the above hypothesis were rejected on the basis of statistical evidence. Any differences in the proportions of "A" and "N" abstracts retrieved, forwarded, and evaluated as relevant or non-relevant, or documents ordered in hard copy or microfiche are not large enough to be statistically significant at the .05 level of confidence. We, therefore, conclude that a preponderance of one source over the other in the output does not exist.

Question 25

Do the questions asked by SBA companies retrieve more potentially relevant material than questions asked by comparison companies?

Related Hypothesis

1. The proportion of retrieved abstracts forwarded (after screening by the Engineering consultants or Center analysts) to SBA companies is significantly larger than the proportion forwarded to comparison companies.

In the case of retrospective searches, the hypothesis cannot be rejected. The SBA companies have received a significantly larger proportion of retrieved abstracts than the comparison companies. The confidence level is less than .001.

However, for current awareness searches, the comparison companies received a larger proportion of retrieved abstracts than SBA companies. Again, the confidence level is less than .001.

Question 26	Related Hypothesis
Do SBA companies find more non-relevant material in the search results forwarded to them than do comparison companies?	1. SBA companies evaluate a larger proportion of the abstracts forwarded to them as non-relevant to their information needs than do comparison companies.

The hypothesis is accepted for the case of retrospective searches at the .001 level of confidence. SBA companies do evaluate a larger proportion of the forwarded abstracts as non-relevant to their needs. However, in the case of current awareness searches, there is no significant difference between the proportion evaluated as non-relevant by the two groups of companies.

Question 27	Related Hypothesis
Do SBA companies find more of the abstracts potentially related to their other (unidentified) interests than do comparison companies?	1. SBA companies find a significantly larger proportion of the forwarded abstracts potentially related to their other (unidentified) interests than do comparison companies.

The hypothesis is rejected for both types of searches. For the retrospective search the comparison companies found more abstracts related to their other (unidentified) interests, while on current awareness searches there is no significant difference in the proportions.

Question 28	Related Hypothesis
Do the SBA companies order more hard copy or microfiche of potentially relevant documents than do comparison companies?	1. SBA companies order a significantly larger proportion of the full text of potentially relevant documents in hard copy or microfiche than do comparison companies.

The hypothesis is rejected for the case of retrospective searches at the

.001 level of confidence. There is no significant difference between the

proportions each group orders for current awareness searches.

Question 29	Related Hypothesis
Do the SBA companies evaluate more of the abstracts forwarded to them as relevant than do comparison companies?	1. The proportion of forwarded abstracts evaluated as relevant for their questions by SBA companies is significantly larger than the proportion judged relevant by comparison companies.

We cannot reject the hypothesis at the .001 level of confidence for retro-

spective searches and, thus, conclude that the SBA companies evaluate a larger

proportion of the abstracts forwarded to them as potentially relevant than do

the comparison companies.

The hypothesis, however, is rejected in the case of current awareness

searches. There is no statistical difference in the proportions evaluated

relevant by the two sets of companies for this type of search.

(c) Effect of the Nature of Industry Problems Addressed to the KASC Service:

Question 30	Related Hypothesis
Is there a qualitative difference in the questions submitted by active companies that differentiate them from attrition companies?	1. Significantly more questions from attrition companies are considered "bad" questions by the Engineering consultant (with respect to company needs vs. type of information in the file) than from companies that remain active.

Empirical evidence refutes this hypothesis. There is no statistical

difference between active and attrition companies as to whether their questions

are considered good or "bad" by the Engineering consultants. For the attrition

companies, exactly half of the questions asked are considered good and half are

considered "bad". For the active companies, slightly more than half are
considered good, and the remaining are considered "bad". Also, there is no
statistical association between good or "bad" questions and company status -
the coefficients of contingency and correlation are both near zero.

The index of predictive association is also zero, thereby, indicating that
knowing the Engineering consultant's opinion of the question (a good or "bad"
question for servicing by KASC system) does not reduce the probability of
being wrong in predicting whether or not the company remains in the system.

Question 31	Related Hypothesis
Are there real differences in questions asked by the two types of companies such that there are differences in the number of retrieved abstracts forwarded to each?	1. Active companies submit questions which have a higher probability of finding potentially relevant information in the file (i.e., the proportion of retrieved abstracts forwarded as potentially relevant to active companies is greater than the proportion forwarded to attrition companies).

The hypothesis is rejected by the evidence. In the case of retrospective
searches, the antithesis is true - the attrition companies are actually for-
warded a larger proportion of retrieved abstracts as potentially relevant than
are the active companies, and the proportion is significantly larger. The
probability of being wrong in rejecting this hypothesis for retrospective
searches is less than .001.

However, there is no significant difference in the proportions forwarded
to the two groups of companies for current awareness searches; therefore, we
also reject this hypothesis for this type of search. The probability of our
being wrong in rejecting this hypothesis for current awareness searches is
approximately .16.

(d) <u>Effect of the Extent of Company Cooperation in Providing Feedback to KASC</u>:

<u>Question 32</u>	<u>Related Hypothesis</u>
Are there any differences between active and attrition companies in their willingness to cooperate with KASC in improving the service? Are companies that remain active more cooperative than attrition companies?	1. Companies that remain active are more cooperative (i.e., the proportion of abstract evaluation forms returned to KASC by them is greater than the proportion of forms returned by attrition companies).

We cannot reject this hypothesis for either case. The proportion of evaluation forms returned by the active companies is significantly greater than the proportion of forms returned by the attrition companies for both current awareness and retrospective searches. With sample sizes as large as those being discussed, the size of the difference does not have to be as great as with smaller samples to be significant at the same level of confidence. The probability of being wrong in not rejecting either or both hypotheses is less than .001. Active companies have been more cooperative about returning evaluation forms.

<u>Question 33</u>	<u>Related Hypothesis</u>
Are SBA companies more cooperative than comparison companies?	1. The proportion of abstract evaluation forms returned to KASC by SBA companies is significantly larger than the proportion returned by comparison companies.

The statistical evidence indicates that the hypothesis is not true and that there is no significant difference between the proportions returned by the SBA companies and comparison companies. Both returned a little more than one-half of the abstract evaluation forms that accompany forwarded abstracts.

(e) <u>Effect of the Level, Quantity, and Quality of Personal Contacts Between KASC Staff and Company Personnel</u>:

<u>Question 34</u>	<u>Related Hypotheses</u>
How crucial is the interaction between the Engineering consultant (and subsequent reviewer) and the company, at the time of contract negotiation and/or formulation of the question(s), as to the willingness of the company to remain in the system?	1. Engineering consultant's participation in the initial presentation to the company is significantly greater for companies that remain in the system than for attrition companies.

We reject this hypothesis; there is no statistical association between the Engineering consultant participating in the initial presentation/ negotiation with the company and the willingness of the company to remain in the system. Statistically, the same proportion of attrition companies have the Engineering consultant participate in the initial presentation as do companies that remain active. The number of Engineering consultants who do participate in the initial presentation is low, i.e., many of the Engineering consultants who review the questions receive them second or third hand. The original Engineering consultant is, in many cases, no longer in the university community.

> 2. Engineering consultant's involvement in the initial creation of the questions for active companies is significantly greater than for attrition companies.

This hypothesis can also be rejected; there is no statistical association between the Engineering consultant's involvement in creating the question with the user and the company's willingness to remain in the system. A larger proportion of the Engineering consultants do participate in creating the question for active companies, but the difference is not significant. The attributes (i.e., Engineering consultants' involvement and company status) correlate very low.

Question 35   Related Hypothesis

Is there any relationship be-
tween the number of personal con-
tacts per year (telephone or visit),
made by the Engineering consultants,
and an inclination on the part of the
companies to remain active?

1. There were significantly more
   contacts per year (telephone or
   visit) made by the Engineering
   consultants with active companies
   than with attrition companies.

This hypothesis is not supported by the data. While there are differences in the number of contacts, these are not significant. However, there is a moderate degree of statistical association between the number of contacts and the companies' status (the coefficient of contingency is .41). The correlation coefficient is somewhat less, being .21, so that we can assume that there is somewhat less of a tendency for the two attributes to occur together.

Roughly half the active companies have 10 or more contacts per year with the Engineering consultants, while less than one-fifth of the attrition companies have that many. Five of the sixteen attrition companies have had three or fewer contacts. One attrition company has more than twenty contacts per year.

The coefficient of predictive association is .44 which indicates that by knowing the number of contacts we can reduce the probability of being wrong in predicting whether or not a company remains active by 44 percent.

Question 36   Related Hypothesis

Do the attrition companies differ
significantly from the active
companies with regard to the level
or type of company personnel with
whom initial contract negotiations
are conducted?

1. More contract negotiators from
   attrition companies are from the
   company officer level (non-
   research oriented personnel) than
   from other levels of organization.

The value of χ^2 (12.73) is large enough to indicate significant differences between the attrition and active companies with respect to the position in the company the contract negotiators hold. The differences are significant at the .025 level (.05 is the level of acceptance). The measures of association are fairly good (λ_B = .36) indicating that by knowing the positions of the contract negotiators within the company, we can reduce the uncertainty in

predicting whether the company remains active or not by about 36%.

Most of the contract negotiators from the attrition companies are at the company officer level (presidents and vice-presidents) while most of the negotiators from active companies are not company officers (rather, research directors and engineers). The latter can be expected to be more research oriented than company officers.

(f) Effect of the Ability of KASC Staff to Predict Probability of Successful Service:

Question 37	Related Hypothesis
After being in contact with the company, and gaining some insight into the company's information needs, can the Engineering consultant predict, with some degree of accuracy, whether or not a company is a good prospect for the KASC service? Do good prospects, so indentified, tend to remain active in the system, while less favorable prospects tend to attrition?	1. Companies which remain active in the system are considered good prospects, in the opinion of the Engineering consultant, in larger proportion than attrition companies.

Statistical evidence does not support this hypothesis although there is a low level of statistical association between the attributes (prospect vs. company status). This is indicated by a coefficient of .17 between the attributes. Companies which are considered good prospects by the Engineering consultant do tend to remain active, while the less favorable prospects do tend to become attrition companies; the trend is slight.

With regard to the question of predictive association the λ_B (index of predictive association) value of .13 indicates that by knowing the Engineering consultant's opinion of the prospect, the probability of error is reduced about 13%. One can predict the probability of a company remaining in the system a little better with knowledge of the Engineering consultant's opinion of the company as a prospect than without this information.

(g) Effect of the Miscellaneous Factors:

Question 38	Related Hypothesis
Is there a significant difference between attrition and active companies based on the dollar value of the contract they sign with KASC?	1. The larger the amount of money involved in the contract signed with KASC, the greater the likelihood of the company belonging to the attrition group.

The χ^2 value of 1.5 indicates that there are no significant differences between attrition companies and active companies with respect to contract size. The distribution for both groups is spread fairly evenly over the range of contract sizes reducing the coefficients of prediction and association to almost zero. The probability that there are no significant differences is between .75 and .90.

Question 39	Related Hypothesis
Does having a NASA contract or sub-contract influence the decision of a company to remain active in the system?	1. Significantly more companies that have a NASA contract or subcontract remain active in the system than companies which do not have such a contract.

We reject the hypothesis with a high probability of being correct in rejecting it ($.25 < p < .50$). There are no significant differences between attrition and active companies with respect to whether or not they hold NASA prime contracts or subcontracts. Roughly one-third of the attrition companies hold NASA contracts, while the proportion for active companies is a little higher.

Holding a NASA contract is not highly associated with company status (the coefficient of contingency and the correlation coefficient are each .10). The index of predictive association is zero from which we can conclude that having information, as to whether or not the company holds a NASA contract, does not reduce the probability of being wrong in predicting company status.

Question 40	Related Hypothesis
Is there any relationship between NASA contractual status (prime or subcontractor) and a propensity of a company to remain active in the system?	1. Companies with NASA prime contracts are more likely to remain active in the system than companies that are NASA subcontractors.

The hypothesis is rejected with a probability of almost .90 of being correct in concluding that there are no significant differences between attrition companies and active companies when categorized on the types of NASA contract involved. The distributions over the attribute "type of NASA contract" are almost indentical making the value of X^2, the coefficients of association, and the index of predictive association zero or almost zero.

VI. Summary of Results

All conclusions that have been drawn from this study must necessarily result from evidence that was not complete. The evidence was based on records of retrieval performance and abstract evaluation forms returned to the KASC. Many of the older records were missing, incomplete, or suspect. Other information came from questionnaires completed by the Engineering consultants or Center analysts. They were asked for their opinions and recollections concerning companies with which they interacted, and their opinions and recollections concerning a sampling of specific questions that they reviewed for the companies. Some of the questions were from companies that had terminated their association with the system as many as two years previously. And, finally, some of the information available for this report, relating to NASA contractors and subcontractors, was confounded to the point that the validity of findings relating to this aspect would be suspect had they been significant. Nevertheless, the evidence provides information about two groups to help point out differences between them if and when such differences exist. Hopefully, significant differences can then be associated with the current status of the companies, i.e., whether or not the company has remained active or has terminated its association.

The conclusions follow the format established for discussing the data.

(a) Effect of the Company Size, Location, and Product Lines:

Hypotheses were made about the companies with respect to the service given to them by KASC. The objective was to determine if there were any differences large enough to separate the two groups of companies, and possibly to find one or more relevant dimensions

which may discriminate between them.

Companies that remained active tended to be large companies, though not significantly more often than small companies. There was some statistical association between company size and membership in the active or attrition group, but the degree of relationship was not high.

The Engineering consultant's opinion of the prospects of a question submitted to KASC for servicing did not have a high degree of predictive association with either the likelihood of a company remaining active or with the dimension of company size. Also, the Engineering consultant's opinions of the abstracts forwarded to the companies were not differentiated by company size. Their opinions as to whether or not a set of abstracts was highly related to the question, was a representative review of the literature, or was a good sampling of the literature were not statistically associated with company size. Lack of association was also indicated by lack of very large differences between the observed frequency for each category and the expected frequency.

The large companies expressed a greater willingness to cooperate with KASC by returning a greater proportion of the abstract evaluation forms (necessary for record keeping and feedback information) that had been forwarded to them than did the small companies.

The small companies were forwarded a relatively greater number of potentially relevant abstracts than were forwarded to the large companies. The small companies also evaluated a larger proportion of the abstracts forwarded to them as relevant than did the large companies. It was the large companies, however, which found a higher proportion of the search results forwarded to them to be non-relevant to their needs. They also found a larger proportion of the abstracts related to their other (unidentified) interests. The large companies

ordered more potentially useful documents in hard copy or microfiche from retrospective searches, while the small companies ordered more hard copy or microfiche from current awareness searches.

Several other factors that might have a latent relationship with a company's decision to continue or discontinue the service were also hypothesized. Statistical tests were performed to aid in making decisions as to the acceptance of these hypotheses. The conclusions are summarized in this section.

There was very little statistical association between the correspondence of the various questions with their respective company SIC code(s) and whether or not a company remained in the system. The attrition companies asked questions directly related to the company's SIC code(s) in roughly the same proportion as the active companies. Also, there were no significant differences between the large and small companies with respect to this relationship between information requests and company SIC code(s).

The factor of geographic distance from KASC was not statistically associated with either company status or company size. The distribution of geographic distances from KASC was nearly the same for both attrition companies and active companies as well as for large and small companies. Distance did not discriminate between any of the four sets of companies.

The holding of a NASA prime contract or subcontract was not associated with company size to a significant degree. However, a higher proportion of large companies held NASA contracts (this proportion was slightly less than the amount needed to be significant at the .05 level). Large companies tended to procure prime contracts, while small companies had a higher proportion of subcontracts (not significant). Nevertheless,

company size was not significantly associated with type of contract held.

(b) **Effect of the Quantity, Quality, and Type of Service Provided by the KASC to Companies:**

    (1) Attrition companies judged a larger proportion of forwarded abstracts as relevant for retrospective searches, but the active companies judged more abstracts as relevant for current awareness searches.

    (2) Attrition companies found relatively more forwarded abstracts related to their other (unidentified) interests than did active companies for both retrospective and current awareness searches.

    (3) Attrition companies ordered a larger proportion of forwarded abstracts in hard copy or microfiche from retrospective searches while, from current awareness searches, the active companies ordered a larger proportion.

    (4) There were no significant differences between the numbers of "A" and "N" abstracts and documents retrieved, forwarded, evaluated, or ordered in hard copy or microfiche. Abstracts and documents from one source were just as acceptable as those from the other source.

As anticipated, an interesting hypothesis supported by the data indicated that the attrition companies found significantly more "noise" in the output. That is, these companies found a significantly larger proportion of the abstracts forwarded to them to be either non-relevant or related to their other (unidentified) interests than the abstracts forwarded to companies that remained active. This was true for both retrospective and current awareness searches.

The SBA companies were forwarded a significantly larger proportion of retrieved abstracts than were forwarded to the comparison group on retrospective searches. However, on the current awareness basis, the SBA companies were forwarded a smaller proportion.

The SBA companies evaluated a larger proportion of abstracts forwarded to them as potentially relevant and, also, a larger proportion as potentially non-relevant for retrospective searches; however, they evaluated a smaller proportion as related to their other (unidentified) interests. There were no significant differences in the proportions related to the above aspects of the service with respect to current awareness searches.

The comparison companies ordered more documents from retrospective searches, but there were no significant differences in the proportion from current awareness searches.

(c) Effect of the Nature of Industry Problems Addressed to the KASC Service:

Attrition companies were forwarded a larger proportion of the retrieved documents as potentially relevant to their needs than were active companies for retrospective searches, but there was no difference in the proportions forwarded to each group for current awareness searches.

(d) Effect of the Extent of Company Cooperation in Providing Feedback to KASC:

Of the several hypotheses supported by statistical evidence, only three were interesting. One of these indicated that the companies that remained active in the system were also more cooperative in returning the abstract evaluation forms to KASC. These forms provide the feedback information as to which abstracts were judged potentially relevant, which

were judged non-relevant, which were related to other (unidentified) interests, and which documents the user desired in hard copy or micro-fiche. In addition, the feedback information might be useful in modifying a search strategy if the results of the search had not met expectations.

Perhaps this result and the interesting findings; in section (b) could be related in the following sense. Finding more non-relevant or only tangentially relevant abstracts in the search results, the attrition companies lost confidence in the system's ability to retrieve information directly useful to their needs. This, in turn, might explain why they returned fewer abstract evaluation forms to KASC.

The SBA companies were just as cooperative as the comparison companies in returning the abstract evaluation forms to KASC. Both returned a little more than half of the forms sent to them.

(e) Effect of the Level, Quantity, and Quality of Personal Contacts Between KASC Staff and Company Personnel:

The large companies expressed a greater willingness to cooperate in that they returned significantly more evaluation forms to the KASC than did the small companies. It was also true that the companies that remained active were more likely to cooperate by returning the evaluation forms to the KASC than were companies in the attrition group. However, there was no significant difference between the SBA companies and the comparison companies on the number of forms returned.

Contrary to the hypothesis, frequent contacts (both personal visit and telephone with KASC consultants) did not have the positive effect on the contract renewal that was expected. There were no significant differences between the number of personal contacts (per year) that would differentiate the active companies from the attrition group. It

had been felt that frequent personal contact with a companies might
present greater inducement for remaining in the system than the
impersonal feedback contact that occur on a periodic basis between
client and consultant; this however, was not supported by the data.
This added anomaly may be explained by (1) no matter the number of
contacts with a company, if utilization of the information provided
is impossible, the attrition will still occur, and (2) the contacts
between the KASC consultant and the companies were not on level of
consultation but something less. It should also be noted, that there
is a natural divider between large and small companies so far as the
number of contacts.

The position in the company hierarchy held by the individual with
whom initial contract negotiations were conducted was a significant
factor in differentiating between both attrition companies and active
companies as well as for large and small companies. The contract
negotiator tended to be a company officer in attrition companies
and not in active companies. The negotiator in small companies was
predominately a company officer (two-thirds of the time the presi-
dent), while in large companies he was a vice-president or less in
almost all cases.

(f) Effect of the Ability of KASC Staff to Predict Probability of
Successful Service:

The opinions of the Engineering consultants were not useful infor-
mation in predicting whether or not a company would remain active in
the system. The index of predictive association for their opinions
was low in all cases.

(g) Effect of the Miscellaneous Factors:

Size of the contract (in dollars per year) was not a factor in dif-

ferentiating attrition companies from active companies, but it was a significant factor in separating large companies from small companies. The distributions were quite different over the attribute of company size. Large companies tended toward large contracts (14 had contracts in excess of $2000) while small companies negotiated small contracts (only 4 out of 35 were in excess of $1000, and none over $2000).

The holding of a NASA contract (prime contract or subcontract) was not statistically associated with company status (attrition or active) nor was the type of contract associated with company status.