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THE EFFECTS OF INFORMATION DIVERSITY ON DECISION QUALITY IN AN UNSTRUCTURED DECISION TASK

by

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THE EFFECTS OF INFORMATION DIVERSITY ON DECISION QUALITY IN AN UNSTRUCTURED DECISION TASK

ABSTRACT

The major objective of this research was to study the effects of information diversity on decision quality in an unstructured decision task. The information diversity in a set of cues was defined as the number of dimensions in the set. Two other independent variables studied were task learning and decision experience. Decision quality was operationalized to profit and decision time.

The results from an experiment conducted to study these variables show that increasing information diversity increases decision time. This effect was hypothesized from theory and prior findings. The hypothesized effects for learning and experience were largely supported. In general, high experience and learning both resulted in higher decision quality. The experiment revealed a number of interactions between the variables. The implications of these findings for practice and future research were considered.

THE EFFECTS OF INFORMATION DIVERSITY ON DECISION QUALITY IN AN UNSTRUCTURED DECISION TASK

INTRODUCTION

The information diversity in a set of cues provided to a decision maker will be defined at this introductory stage as the number of dimensions in the set. Research is needed into the effects of information diversity on decision quality and accountants and systems analysts should have an interest in such research. This is because (1) there is evidence which suggests that information diversity may affect decision quality, (2) we currently have little knowledge about the nature of such effects and, (3) accountants and analysts have available alternative accounting and reporting methods which vary information diversity. This argument assumes information professionals are interested in the decision making performance resulting from the information they produce, and how they may improve such performance. The argument will be pursued in a little more detail.

Accounting and systems researchers have shown that "information structures affect [decision-making] performance" (Lewis, 1984). Examples of such structures are: aggregation (Abdel-Khalik, 1973; Barefield, 1972), raw data and statistically summarized data (Chervany and Dickson, 1974), value and events accounting (Benbasat and Dexter, 1979), information load (Driver and Mock 1975; Casey, 1980), and information supply and demand (Shields, 1983). Information diversity may be regarded as an information structure, and it too may affect decision quality. Indeed, as will be shown below, a number of the

above structures (e.g. information load) confound a number of variables together, one being information diversity. The effect attributed to the structure may, in fact, be due to information diversity. Psychologists, Schroder, Driver and Streufert, (1967; Streufert, S.C., 1972; Streufert, 1973) regard information diversity as an element of environmental complexity. They have developed a theory in which environmental complexity has an inverted U curve relationship with human information processing. Since decision quality is a result of human information processing, this theory suggests that environmental complexity may affect decision quality. Empirical tests of Schroder, Driver and Streufert's theory largely support it (Schroder et al., 1967; Streufert, 1970; Streufert, S., 1972; Streufert and Streufert, 1969; Streufert, S.C., 1972; Streufert, 1973). However, they have not tested the theory in relation to the information diversity element of environmental complexity.

While the discussion in the previous paragraph indicates that information diversity may affect decision quality, we currently have very little knowledge about the nature of the effect. Accounting and systems researchers have not studied the variable directly. It is true they may have studied it indirectly in the process of studying other structures (e.g. load). However, as will be shown below, in all such cases, information diversity has been confounded with other variables such that its effect cannot be determined. While Schroder et al. include information diversity in their theory, they have not tested the theory in relation to that variable. In addition, their theory has differentiation and integration of information as dependent variables, not decision quality. Consequently, we have little knowledge about the effects of information diversity on decision quality.

Information professionals should be interested in the nature of these effects. This is because they have available alternative accounting and reporting methods which vary information diversity. Examples of such alternative methods are: aggregation, summarization, models, exception reports, explanatory footnotes, multiple reports, and decision support systems. The use of such alternative methods often will result in varying information diversity. This in turn may affect decision quality. If it is assumed accountants and analysts are interested in the effects the alternatives available to them have on decision quality, then they should be interested in the effects of information diversity.

This paper describes an experiment that seeks to provide insight into the relationship between information diversity and decision quality. Two other independent variables included are practical decision-making experience and task learning. These variables were included because (as will be shown below) there is evidence they may interact with information diversity.

The paper proceeds as follows. The remainder of this section discusses the nature of the variables studied, and the decision-making task used. Following sections discuss, relevant empirical research in accounting and information systems, research hypotheses, method, results and discussion, and conclusion.

The major independent variable studied in this research is information diversity. This variable was defined at the beginning as the number of different dimensions in a set of cues provided to a decision maker. The concept will now be elaborated. If a decision maker has a set of cues to

make a decision with, some of these cues may represent different dimensions and some may be repeated dimensions. For example, assume the following cue set:

Time (years)	0	1	2	3	4
Cash Flow	-10000	3000	3000	2800	2700
Cost of Capital	10%				

Here there are 11 cues (5 time periods, 5 cash flows, and 1 cost of capital), but there are only three dimensions (time, cash flow and cost of capital).[1] Eight of the cues are repeated dimensions - after the initial time and cash flow there are four more repetitions of each of these dimensions (the values are different but the dimensions are the same). The Schroder, Driver and Streufert theory (Schroder et al. 1967; Streufert, S.C., 1972; Streufert, 1973) suggests that repeated dimensions will affect decision quality differently from different dimensions - n repeated dimensions should be easier to process than n different dimensions.

The number of different dimensions in a cue set may be called the absolute information diversity of the set (in the above example absolute diversity is 3). Relative diversity is the number of dimensions divided by the number of cues (3/11 or 27.3% in the example). The quantity of repeated dimensions is the number of cues less the number of dimensions (8 in the example).

Two additional independent variables studied in this research are unstructured-decision-making experience and decision-task learning. Harvey,

Hunt, and Schroder (1961) have found that decision makers can learn to process higher environmental complexity. Experience and task learning are two different types of learning. Unstructured-decision-making experience involves learning through experience over a range of unstructured decision tasks. Task learning involves learning on a particular decision task. The expert systems literature (e.g. Hayes-Roth, Waterman and Lenat, 1983) also supports the study of task learning and experience. Experts generally behave differently from novices and one way experts become expert is through experience and task learning.

The dependent variable in this research, decision quality, was operationalized to the two variables, profit and decision time. These latter two variables are two important dimensions of decision quality in practice. In practice, additional decision time has an opportunity cost.

In research on information structure it is important that the nature of the decision task is specified. This is because Libby and Lewis (1977) and Schroder, Driver and Streufert (1967) argue that the effects of information structure may vary with context. Fleishman (1982) argues that, in general the nature of the task has an important effect on human performance. The research in this paper uses an unstructured task. Decision makers will be unable to model the task completely. A heuristic decision process is necessary. Mason and Mitroff (1973) regard the structured/unstructured decision continuum as most important. Both types of decision require research because the decision processes involved are likely to be different and the findings for one may not apply to the other. Unstructured decisions are commonly found in practice at the middle and upper levels of management.

EMPIRICAL RESEARCH IN ACCOUNTING AND INFORMATION SYSTEMS

To this writer's knowledge no other research has investigated the separate effects of information diversity. There are a number of papers on related topics of information structure, but unfortunately, none is strictly relevant to this paper. There are three reasons:

(i) Some (e.g., Pratt, 1982; McGhee, Shields and Birnberg, 1978; Benbasat and Dexter, 1982) have studied individual differences which are not the concern of this paper. Lewis (1984) supports the approach taken here when he states:

> The overwhelming evidence to date is that information structures affect performance, that cognitive characteristics do not affect performance and that information structures and cognitive characteristics do not interact with respect to performance.

(ii) Others, (e.g., Shields, 1980; Shields, 1984; Snowball, 1980) have studied dependent variables other than the ones studied here (profit and decision time).

(iii) Some researchers (e.g., Barefield, 1972; Abdel-Khalik, 1973; Chervany and Dickson, 1974; Driver and Mock, 1975; Benbasat and Dexter, 1979; Casey, 1980; Shields, 1983; Mock and Vasarhelyi, 1984) have varied information diversity indirectly in the process of studying the effects of other aspects of information structure on decision quality e.g., aggregation, information load, value and events accounting, and information supply and demand. Since these studies were not really interested in investigating information diversity it should not be

surprising that in all cases that variable has been confounded with others. The confoundings in all papers are similar. Consequently, for brevity, they will be illustrated by reviewing only the Casey (1980) paper.

Casey (1980) studied information load. He manipulated the variable over three levels as follows. The low load group received six ratios for three years for a number of firms 50% of which had gone bankrupt. The moderate load group received these ratios plus balance sheets and P & L statements. The high load group received the previous information plus notes to the statements. Dependent variables were bankruptcy-prediction accuracy and decision time. The results were: the moderate group predicted significantly better than the low group and did not spend more time; the high group spent significantly more time than the moderate group and did not predict more accurately.

Unfortunately, Casey (1980) seems to confound five variables together in his load manipulation - uncertainty, irrelevant data, information diversity, repeated dimensions, and information value. It is probable that as load increased, irrelevant data would increase, uncertainty would change, the number of different dimensions of information (information diversity) would increase, and the quantity of repeated dimensions of information would increase. The information value confounding is less obvious requiring greater explanation. As information load increased in Casey's experiment so probably also would the value of the information. These two effects (load and value) are confounded together. The load effect is of a cognitive psychological nature. It is due to the inability of humans to process high volumes of information. Information

value is the added profits due to the information resulting in better decision making. Information can be valued using a statistical mathematical calculation described in Committee on Managerial Decision Models (1969); Davis (1974); or Cook and Russell (1981).

The confounding of these five variables together means that the effects of any one are unknown. We do not know how much of the overall effect is due to any particular variable. The effects of the individual variables need to be untangled because they may be different, and because their relative strengths may vary from decision to decision. Permitting them to remain confounded in future experiments will be a likely cause of inconsistent results. Since all of the papers in (iii) above contain similar confoundings, they, along with Casey's (1980) paper, add little to our knowledge about the effects of information diversity on decision quality.

This review of Casey's (1980) paper clearly illustrates the importance of controlling non-experimental variables in research in the information structure area. Failure to do so will be a likely cause of inconsistent results in different experiments, a situation which has been widespread in the past. The author believes that it is time to try to achieve greater control in research in this area. Consequently, a prime objective of this research has been control over the experimental task in order that confoundings might be eliminated.

RESEARCH HYPOTHESES

There are a number of ways that information diversity might be studied. It is studied in this research as follows. Relative diversity within a constant

cue set size is studied by holding the number of cues constant and varying relative diversity i.e. within a constant cue set size, different dimensions are substituted for an equal number of repeated dimensions (and vice versa) and the effects noted.

Hypotheses about the effects of relative information diversity will be developed from the research in psychology of Schroder, Driver and Streufert.[2] Schroder, Driver and Streufert's theory proposes that if environmental complexity is plotted on the X axis, and level of information processing on the Y axis, an inverted U curve will result. Information diversity is an element of environmental complexity and the theory argues that each element separately will produce the effect. Schroder, Driver and Streufert have most commonly operationalized level of information processing to numbers of information differentiations and integrations. The empirical findings support the theory when number of integrations is the dependent variable. In this case the curve has regularly peaked at 10 cues "of diverse information". However, with number of differentiations as the dependent variable, Streufert (1970) found that while the curve ceased to rise at about the same point (10 cues of diverse information) it then levelled out and became asymptotic to the X axis.

Applying this theory to the development of information diversity hypotheses results in the following:

H1: as relative diversity increases, profit will reduce.

H2: as relative diversity increases, decision time will increase.

The following section shows that in the experiment conducted in this research, both high and low relative diversity subjects received more than 10 cues of

diverse information. Hence all subjects should be on the downward slope of the SDS integrations curve and on the level part of the SDS differentiations curve. According to Schroder, Driver and Streufert the higher diversity subjects would have higher environmental complexity (than the lower diversity subjects), and consequently would be able to carry out fewer information integrations and only the same number of differentiations. However, if high diversity subjects were to make decisions of equal quality to low diversity subjects, they would have to make a higher number of differentiations and integrations. More differentiations would be required to describe the additional dimensions in the high diversity information and more integrations would be required to relate them. Since high diversity subjects are unable to carry out the required information processing their decision quality should fall and this should manifest in reduced profit and higher decision time.

Harvey, Hunt and Schroder (1961) have found that subjects can learn to process higher levels of environmental complexity. The finding is that subjects with higher learning process more information at all levels of environmental complexity. It is assumed here that the higher the amount of information processed the higher the resulting decision quality. Since decision-making experience and task learning are two different types of learning this argument leads to the following hypotheses:

H3: as decision-making experience increases, profit will increase.

H4: as decision-making experience increases, decision time will reduce.

H5: as task learning increases, profit will increase.

H6: as task learning increases, decision time will reduce.

Experience and task learning may interact with information diversity and with each other. However, current theory is inadequate to provide a base for

hypothesizing such interactions. Any interactions found in this research may be used as the basis of future hypotheses.

METHOD

Subjects

Twenty subjects with practical unstructured decision-making experience and 20 subjects with no such experience were used. Experienced subjects were employed in business and government administration. Their experience ranged from two to twenty years with a mean of 9.3 years. Inexperienced subjects were students in an advanced undergraduate course in the Department of Accounting at the Queensland Institute of Technology. All subjects were familiar with the type of information provided in the experiment.

Design

The experiment in the research used a 2 x 2 x 2 factorial design where there were: (1) two levels of relative diversity, (2) two levels of decision experience and (3) two levels of task learning. Task learning was a repeated measures factor. Subjects in the two experience groups were randomly assigned to the two relative diversity groups.

Experimental Task

This section discusses in turn (1) the general nature of the experimental task, (2) the manner in which the independent and dependent variables were

operationalized, (3) the manner in which extraneous variables, which have been confounded in prior research, were controlled, and (4) the reliability and face validity of the task.

General Nature of the Task

The aim in constructing the task was to produce a reasonably realistic yet not too complex unstructured decision-making task. Subjects were required to "manage" individually a firm in a simulated market. The task was conducted in a series of seven sessions of approximately one hour each (one session per week). In the first introductory session subjects studied a Manual that described the task, and questions were answered. The manual described the firm and the market in which it operated. The firm was competing against two competitors in three areas of approximately equal market potential. Subjects were advised their goal should be profit maximization. To assist subjects in estimating the relationships between variables the Manual provided them with the results of their firm from the immediate past period and with details of competitor decisions from two immediate past periods.

In subsequent sessions each subject managed his/her firm. In each session subjects managed their firm for one period and made a set of managerial decisions. The decision set was: for each area - price, advertising expenditure, number of salespersons hired, salespersons fired, products ordered; for the whole firm - credit terms, delivery expenditure. At the completion of each session, decision sets were processed by a computer program which simulated the market.[3] Competitor decisions were built into the simulation program by the experimenter.[4] To make the results of experimental conditions

comparable, each competed against the same set of competitor decisions. Further details about how this was achieved will be given shortly. Given the decisions of the subject and his/her competitors the program calculated the firm's orders received, results, and financial position for the period. These, together with competitor and some other information were outputted by the program in a Management Report (see Appendix 1). This report was given to the subject at the beginning of the next session.

Operationalization of Variables

Recall that this experiment studied relative information diversity within a constant cue set size. Relative diversity was manipulated over two levels (high and low) by giving subjects incomplete information about the prices and advertising expenditures of the two competitors. The management report (see Appendix 1) provided to subjects at the beginning of each period contained information about competitor prices and advertising expenditures in the immediate past period. The incomplete information about the two competitors was manipulated so as to give one experimental group information of higher relative diversity than the other group. This was done as follows:

Low information diversity group:

(i) half of the group received price information about the two competitors but no advertising information;

(ii) the other half received advertising information but no price information.

High information diversity group:

(i) half of the group received price but no advertising information for Competitor 1, and advertising but no price information for Competitor 2.

(ii) the other half received advertising but no price information for Competitor 1, and price but no advertising information for Competitor 2.[5]

The subject manual for this experiment advised that competitor information was obtained by a market survey, and that this survey seldom provided complete information. In fact it was always incomplete.

The above description of the competitor price/advertising manipulation shows that, the low diversity group received only <u>one</u> type (price <u>or</u> advertising), while the high diversity group received <u>two</u> types (price <u>and</u> advertising). Assuming that price and advertising are two different dimensions in the competitor information, then the high diversity group received one more dimension of information than the low diversity group. Note also that the number of cues was the same for both experimental groups. Thus relative diversity has been manipulated within a constant cue set size - and the high diversity group received relatively more diverse information (one additional dimension) than the low diversity group. The assumption that price and advertising were two different dimensions was tested by correlating price with advertising in the decisions made by the subjects. The Pearson r coefficient was -.057 which was not significant. The low value of the coefficient indicates that price and advertising were two different dimensions in the decision making of subjects. It shows that a number of different price/advertising strategies were used. Consequently, it seems reasonable to

assume that price and advertising would have been perceived by subjects as two different dimensions in the competitor information.

It might be argued that this operationalization of information diversity is not a strong one - high diversity information is only one dimension greater than low diversity information. However, the operationalization is designed to permit the control of extraneous variables, a prime objective in this research. This will be discussed in the next section.

The variable "task learning" was operationalized to two levels by having subjects play one set of three periods (trial 1) and then restarting the simulation and having a second set of three periods played (trial 2).[6] Subjects were not advised of the number of periods in each trial to avoid "end-of-game" effects. Learning effects were measured by comparing the results from the two trials.

Profit and decision time were the dependent variables. Profit was measured using generally accepted accounting standards (see Appendix 1). Decision time was measured using a digital stop clock.[7]

Control of Extraneous Variables

A prime objective of this research was to control variables that have been confounded in prior research in related areas (refer to earlier review of Casey (1980)). Note that, taken as a whole, the high and low diversity groups are completely balanced as far as information received is concerned. In each group: (i) half received price information about Competitor 1, (ii) half received

price information about Competitor 2, (iii) half received advertising information about Competitor 1, and (iv) half received advertising information about Competitor 2. This information balancing controls for uncertainty and information value. Irrelevant data is controlled because, a priori, there is no irrelevant data in the information manipulated in operationalizing information diversity (i.e., it is assumed competitor price and advertising information is relevant to each subject).

A further control was needed to guard against the possibility that a competitor may be easier to compete against in one trial than the other. Note that for each of the two trials, a separate decision set was necessary for each competitor. The two decision sets for each competitor will be referred to sets A and B. The desired control was achieved by balancing competitor decision sets over the two trials such that half the subjects in each diversity group competed against set A in trial 1 and set B in trial 2, while the other half competed against set B in trial 1 and set A in trial 2.

Reliability and Face Validity

The reliability and face validity of the task were measured. The reliability coefficients of equivalence (Brown, 1970) were: profit, .272*; decision time, .639** (* = $p < .05$; ** = $p < .01$). The coefficients are significant at the .05 level and are considered satisfactory for the purposes of this research, bearing in mind that Nunnally (1970) argues that lower standards are acceptable in instruments used for research, compared with those used in applied (e.g. clinical) psychology.

The face validity of the task was measured by having subjects rate on a five point rating scale (1 = very unreasonable; 5 = very reasonable) the degree to which they believed the task "would represent practical decision making of an unstructured type". Dubin (1978) argues that validity can only be measured in a judgmental fashion such as this. He is highly critical of criterion measures of validity. The mean rating was 2.85. This is closest to the 3 point on the scale which was labelled "in between". Considering that it is always very difficult to simulate real life situations in the laboratory, these ratings are regarded here as satisfactory.

RESULTS AND DISCUSSION

The two dependent variables were first correlated to see if they were separate dimensions of decision quality. Separate Pearson r coefficients were calculated for each learning trial. Partial-correlation analysis was carried out to remove the effects of information diversity, and experience. The coefficients were .138 for trial 1 and .351 for trial 2. The former is not significant while the latter is significant at the .05 level. These coefficients seem to indicate that the relationship between profit and decision time is low. Consequently, they should be treated as two separate dimensions of decision quality.

Research hypotheses were tested with ANOVA and Newman-Keuls post hoc analysis. Tables 1 and 2 show the ANOVA tables for profit and decision time respectively. Table 3 gives the means for main effects and two-way interactions which are significant or approach significance ($p < .1$).

Tables 1 and 2 reveal that relative diversity has had an effect on decision time but not on profit. Table 3 shows that the time means are as predicted by H2 - as relative diversity increases, decision time increases. Hence H2 is supported but H1 is not. The information diversity effect on decision time is substantial. High diversity time is 128.6% of low diversity time. This effect has been produced with only one additional dimension of information. Greater differences in information diversity may produce even more substantial effects. This should be investigated in future research.

INSERT TABLES 1, 2 & 3 ABOUT HERE

In the decision-time results (see Table 2), an interaction between information diversity and learning approaches significance ($p = .095$). The means in Table 3 indicate that learning reduces the effect of information diversity on time, but the effect still remains in the second trial.

Tables 1 and 2 show that learning has had a strong main effect on both profit and time. The means (Table 3) show that H5 and H6 are supported. Increased learning has increased profit and reduced time. Learning has also been involved in four interactions. One (diversity x learning) was discussed in the previous paragraph. The other three will be considered shortly.

Although there are no experience main effects, the experience hypotheses H3 and H4 are partly supported in three interactions - diversity x experience, and learning x experience in both profit and time results (see Tables 1, 2 and 3). Newman-Keuls post hoc analysis of the diversity x experience interaction

reveals that (i) at the low diversity level, high experience subjects made more profit than low experience subjects ($p = .052$); but at the high diversity level, profit differences due to experience were insignificant; and (ii) at the low diversity level, time differences due to experience were insignificant; but at the high diversity level, high experience subjects took significantly less time ($p = .062$). Hence, high experience subjects have performed better in terms of one measure of decision quality (but not both) at each diversity level. Consequently H3 and H4 are partly supported. Newman-Keuls analysis of the learning x experience interactions show that at the low learning level, high experience subjects made more profit ($p = .058$) and took significantly less time ($p = .056$) than the low experience subjects. However, increased learning eliminates these effects. Hence H3 and H4 are supported at the low learning level.

Table 2 shows a significant 3-way interaction. Newman-Keuls post hoc analysis reveals that the experience effect on time is strongest in the high diversity, low learning condition. It seems that experience made a greater difference at the more difficult high diversity level, but that increased learning reduced this effect.

CONCLUSION

The previous section shows that a number of the research hypotheses have been supported. Table 4 summarizes the hypotheses and the degree to which they have been supported in the empirical tests. The support for hypothesis H2 provides a confirmatory test of the Schroder, Driver, and Streufert[8] theory in relation to the relative information diversity element of

environmental complexity. The theory was previously untested in respect of that element. This research has also produced a number of interactions between the independent variables. Current theory was not sufficiently developed to enable the statement of hypotheses about such effects. Consequently, interaction findings require replication before emphasis can be placed upon them.

INSERT TABLE 4 HERE

In this research, information diversity did not affect profit. However, if high diversity subjects had been restricted to the lower decision time used by low diversity subjects, the literature (e.g., Wright, 1974) suggests that they would have made lower profit. This is because high diversity subjects took significantly more decision time than low diversity subjects, and restricting the high diversity subjects to the low diversity time would have placed them under time pressure. The literature shows (e.g., Wright, 1974) that time pressure results in lower quality decision making (e.g., lower profit). Future research should investigate this issue more fully.

The findings in this research have practical implications which will now be considered. The major practical implication concerns the effects of relative information diversity. Higher information diversity has resulted in substantially higher decision time for both high and low experienced subjects. The effect has been produced with only a small difference (one dimension) in information diversity. Larger differences may produce stronger effects and may affect profit. There is a need for further research in that regard. Nevertheless, given that decision time has an opportunity cost, the findings at this stage

seem to suggest that in practice the accountant and analyst should be concerned if a decision maker is to be provided with a report containing a high number of different dimensions (information diversity). In this case, consideration should be given to the use of aggregation, models, or exception reporting to reduce the number of dimensions. Also there should be concern if the use of explanatory footnotes or multiple reports results in a considerable increase in information diversity. More research findings are necessary to give practitioners more concrete guidelines on these issues.

The findings here also have implications for future research. First, as noted in the previous paragraph, research is needed into the effects of information diversity at levels other than those studied in this paper. Second, research is needed to test if restricting high diversity subjects to the decision time of low diversity subjects will result in lower profit. Also, a more sophisticated variable/dimension model should now be investigated. This research studied information diversity by manipulating two variables which were different dimensions. A more sophisticated model would also cover situations where two or more variables were correlated (i.e. they load on the same dimension), and where a variable loads on two or more dimensions. A further implication is that this research shows that inexperienced decision makers are not good surrogates for experienced decision makers. Experience has had significant effects on both dependent variables and has been involved in a number of interactions. While task learning has also had both main and interactive effects, this variable does not have the same important implications because task learning is normally low in unstructured decision making in practice. The earlier review in this paper of prior research, indicates that in

future research, considerable care should be taken to control possible confounding variables.

FOOTNOTES

[1] This assumes each type of variable is a different dimension. In other words, it assumes that correlations between pairs of variables are insignificant. Factor analysis would be necessary to see if this assumption is correct. Of course in practice, it is sometimes found that variables are correlated (i.e. they load on the same dimension), and that one variable may load on more than one dimension. This research elects to study the more fundamental issue first, and thereby makes the above assumption. If this produces significant results the assumption should be relaxed, and situations where two or more variables are correlated, and where a variable loads on two or more dimensions should be studied.

[2] Schroder et al., 1967; Streufert, 1970; Streufert, S., 1972; Streufert and Streufert, 1969; Streufert, S.C., 1972; Streufert, 1973. Caution must be exercised in generalizing from this research to the managerial decision-making area.

[3] The simulation model incorporated the economic concepts of demand curve (for price) and declining marginal utility for advertising and salespersons. Subjects were not advised these relationships or of the effect of credit terms. It would not have been possible for subjects to work out these relationships accurately by trial and error within the time constraints of the experiment.

[4] The experimenter attempted to make decisions representative of practical decision making. The validity results discussed later seem to indicate that subjects found them such.

[5] The management report provided information other than that manipulated (competitor price and advertising). However, this other information was the same for both experimental groups. Consequently, it does not affect the operationalization of information diversity.

[6] Two sets of three sessions + the introductory session = the 7 sessions mentioned earlier.

[7] The profit for each subject for each trial was measured by adding the profits for the three periods in the trial. The decision time for each subject for each trial was measured by adding the decision times for the second and third periods in the trial. The reason the time for the first period was eliminated was that in the first period of the first trial subjects did not have to study their results from the previous period, whereas in the first period of the second trial this was necessary (they received the results from period 3 of the first trial). Times for the second and third periods in trial 1 were, however, comparable with those for the same periods in trial 2.

[8] See footnote 2.

Source	S.S.	D.F.	M.S.	F	PROB.
Between Ss					
A. Experience	247.95	1	247.95	.19	
B. Info. Diversity	.97	1	.97	.00	
A x B	7853.48	1	7853.48	5.92	.019
Error Between	47785.56	36	1327.37		
Within Ss					
C. Learning	12415.14	1	12415.14	16.78	.000
A x C	2765.25	1	2765.25	3.74	.058
B x C	354.49	1	354.49	.48	
A x B x C	645.35	1	645.35	.87	
Error 2	26637.08	36	739.92		

Table 1: ANOVA of Profit ($'0000)

Source	S.S.	D.F.	M.S.	F	PROB.
Between Ss					
A. Experience	189.67	1	189.67	1.08	.307
B. Info. Diversity	976.78	1	976.78	5.55	.023
A x B	528.91	1	528.91	3.01	.088
Error Between	6336.23	36	176.01		
Within Ss					
C. Learning	9139.95	1	9139.95	140.20	.000
A x C	248.16	1	248.16	3.81	.056
B x C	187.82	1	187.82	2.88	.095
A x B x C	610.84	1	610.84	9.37	.004
Error 2	2346.86	36	65.19		

Table 2: ANOVA of Decision Time (mins.)

Effect	Level of Interaction Variable 1	Level of Interaction Variable 2	Mean	
			Profit ($'0000)	Time (Mins)
diversity	main effect.	low high	ns	24.48 31.48
learning	main effect.	low high	41.91 66.83	38.67 17.29
div. x exper.	low div.	low exper. high exper.	42.59 65.93	ns
	high div.	low exper. high exper.	ns	35.59 27.36
learn. x exper.	low learn.	low exper. high exper.	34.28 49.56	41.97 35.37
	high learn.	low exper. high exper.	ns	ns
div. x learn.	low learn.	low div. high div.	ns	33.64 43.70
	high learn.	low div. high div.	ns	15.33 19.26

Table 3: Main Effect and 2-Way Interaction Means

(ns = not significant)

Hypothesis	Support
H1: as relative diversity increases, profit will reduce	Nil
H2: as relative diversity increases, decision time will increase	Full
H3: as experience increases, profit will increase	Partial
H4: as experience increases, decision time will reduce	Partial
H5: as task learning increases, profit will increase	Full
H6: as task learning increases, decision time will reduce	Full

Table 4: Summary of Research Hypotheses and Results from Their Empirical Tests

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APPENDIX 1

MANAGEMENT REPORT

MANAGEMENT SIMULATION

COMPANY NO. 123581 — RESULTS FOR PERIOD 0

COMPETITOR INFORMATION

		AREA 1	AREA 2	AREA 3
COMPETITOR 1	PRICE ($)	100	100	100
	ADVERTISING ($)	100000	100000	100000
	NUMBER OF SALESMEN SELLING	30	30	30
	CREDIT TERMS	30 DAYS	30 DAYS	30 DAYS
	ORDERS RECEIVED (UNITS)	10000	10000	10000
COMPETITOR 2	PRICE ($)	100	100	100
	ADVERTISING ($)	100000	100000	100000
	NUMBER OF SALESMEN SELLING	30	30	30
	CREDIT TERMS	30 DAYS	30 DAYS	30 DAYS
	ORDERS RECEIVED (UNITS)	10000	10000	10000

YOUR COMPANY AREA SALES ANALYSIS

	AREA 1	AREA 2	AREA 3
ORDERS RECEIVED (UNITS)	10000	10000	10000
SALES VOLUME (UNITS)	10000	10000	10000
PRICE	100	100	100
ADVERTISING	100000	100000	100000
NUMBER OF SALESMEN SELLING	30	30	30
CREDIT TERMS	30 DAYS	30 DAYS	30 DAYS

PROFIT AND LOSS STATEMENT

SALES REVENUE		3000000
EXPENSES		
COST OF GOODS SOLD (AV COST $64.6900)	1940700	
ADVERTISING	300000	
SALESMENS SALARIES	75600	
SALESMENS HIRING COSTS	0	
MARKET SURVEY	5000	
DELIVERY-STANDARD	30000	
DELIVERY-SPECIAL	0	
ADMINISTRATIVE EXPENSE	300000	
DEPRECIATION	7333	
INVENTORY CARRYING COST	25876	
ORDERING COST	18000	
INTEREST ON OVERDRAFT	0	2702509
PROFIT BEFORE INCOME TAX		297491
INCOME TAX		126434
PROFIT AFTER INCOME TAX		171057
DIVIDEND		120000
ADDITION TO OWNERS EQUITY		51057

CASH FLOW

RECEIPTS-DEBTORS		2970000
RECEIPTS-CASH SALES		0 2970000
DISBURSEMENTS		
PURCHASES	1960200	
CASH EXPENSES (EXCLUDING DEPN & COST QDS SOLD)	754476	
INCOME TAX	126434	
DIVIDEND	120000	2961110
CHANGE TO CASH ASSETS		8890

BALANCE SHEET

ASSETS		
CASH	1000000	
DEBTORS	4960200	
INVENTORY	646900	
BUILDINGS FIXT. & FIT. (NET OF DEPN)	4392667	10999767
LIABILITIES		
BANK OVERDRAFT	0	
OWNERS EQUITY	10999767	10999767

OTHER INFORMATION

	TOTAL	AREA 1	AREA 2	AREA 3
TOTAL PROFIT TO DATE ($,BEFORE DIVIDEND)	171057			
RATE OF INFLATION DURING PERIOD (PERCENT)	1.0			
INVENTORY AV COST AT BEGINNING OF NEXT PERIOD	65.1775			
INVENTORY AT END OF PERIOD (UNITS)	10000	3333	3333	3334
INVENTORY AT BEGINNING OF NEXT PERIOD (UNITS)	40000	13333	13333	13334
NUMBER OF SALESMEN AT BEGINNING OF NEXT PERIOD	90	30	30	30