DECISION OUTCOMES UNDER ACTIVITY-BASED COSTING: PRESENTATION AND DECISION COMMITMENT INTERACTIONS

David Shelby Harrison and Larry N. Killough

ABSTRACT

Activity-based costing (ABC) is presented in accounting textbooks as a costing system that can be used to make valuable managerial decisions. Little experimental or empirical evidence, however, has demonstrated the benefits of ABC under controlled conditions. Similarly, although case studies and business surveys often comment on business environments that appear to favor ABC methods, experimental studies of actual behavioral issues affecting ABCs usage are limited.

This study used an interactive computer simulation, under controlled, laboratory conditions, to test the decision usefulness of ABC information. The effects of presentation format (theory of cognitive fit and decision framing), decision commitment (cognitive dissonance), and their interactions were also examined. ABC information yielded better profitability decisions, requiring no additional decision time. Graphic presentations required less decision time, however, presentation formats did not significantly affect decision quality (simulation profits). Decision commitment beneficially affected profitability decisions, requiring no additional

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time. Decision commitment was especially influential (helpful) in non-ABC decision environments.

1. INTRODUCTION

Activity-based costing (ABC) methods enjoy popular acceptance in both academic and business environments.[1] While it is clear that ABC methods add precision to indirect cost assignment, the value of indirect cost assignments, precise or not, is questioned by some (Goldratt, 1984, 1994, 1999; Johnson, 1992; Cooper, Kaplan, Maisel, Morrissey, & Oehm, 1992; Anderson, 1995; Hiromoto, 1988). This issue was underscored at the 2004 IMA national conference in Chicago, which featured, during the "Battle of the Cost Accountants" session, a spirited debate centering on just how valuable ABC really is. Yet, ABCs popularity in the classroom and in practice remains well established. The presumption of ABC effectiveness lies in the rational position that better cost information leads to better decisions. While it can be demonstrated that ABC provides more accurate cost information, rationality aside, the extension of this position to the notion that better cost information yields better strategic decisions lacks empirical support.

Drake, Haka, and Ravenscroft (1999) found in an experiment using MBA students that behavioral influences on the use of ABC information had greater effects on (experimental) firm profits than the information content itself. The issue of information receptiveness and information processing, human cognition, underlies the decision usefulness of any analytic tool such as ABC. Receptiveness factors can amplify or impede decision processes, often strongly affecting decision-making outcomes. As Drake et al. (1999) demonstrated, behavioral factors may at times be more consequential than the information content itself.

Our study also looked beyond the "ABC, does it work?" question. We started with the simple, objective, ABC usefulness question, and then included the effects of two related cognition factors, presentation format and decision commitment. We built an interactive business simulation, as a platform, to measure the effects of ABC information and our two behavioral factors on decision quality (simulation profits) and decision efficiency (time). Our three conditions (ABC information, presentation format, and decision commitment) were tested using 48 accounting majors in their junior and senior years at a research university. A mixed-factor ANOVA using repeated measures for two of the three factors was used. All experimental conditions were completely counterbalanced.

Findings supported the notion that ABC information could be very relevant to successful decision strategies, as, under our experimental conditions, ABC information very significantly out-performed traditional, single-driver, traditional cost (TC) information. Importantly, the more detailed ABC information did not require more (or less) time to analyze. Graphic presentations did take more time for participants to analyze, however, results (profits) were not affected by presentation mode. Decision commitment, interestingly, improved decision profits in the non-ABC environment, but was not significant in the ABC interaction. Across all factors, decision commitment was significant, as a single factor, for the profitability response variable, while decision time again was not significant either in the single or mixed factor results.

That ABC information improved profits without requiring additional decision time is comforting to those favoring ABC, especially as it might have been argued that the better profits were attributable to more decision time had that been the case. Similarly, the presentation results complemented each other well. The fact that graphic presentations required more decision time, but yielded the same profits, supports the decision efficiency advantage of numeric formats in our setting. Had the graphs outperformed the numeric formats in profits realized, it would have obviated the efficiency (time) advantage of the numeric formats, as one would then have to give subjective weighting to the value of better decisions (higher profits) vs. faster ones. This did not occur; presentation affected decision time, without interference on performance. Of course, had either ABC or numeric presentation outperformed their counterparts in both profits and time, the conclusions would be simpler and more compelling. As it is the results are complimentary and consistent.

Our work on the effects of decision commitment built on cognitive dissonance decision research (cognitive dissonance impedes effective decision processes), including the effects of commitment, confirmation, and feedback on the usefulness of cost systems, and resistance to systems changes (Jermias, 2001; Brockner, 1992; Whyte, 1986; Straw, 1976). Decision-commitment favorably affected simulation profits overall, however, most revealing was that decision commitment most powerfully affected profits in the TC, and not the ABC environment. By its nature TC cost feedback was often inconclusive, perhaps misleading, causing frustration, and breaking down efficient problem solving decision approaches.

Strengthened commitment, apparently reduced frustration over the TC information disconnects; cognitive dissonance was less engaged. Those less committed endured more dissonance, frustration: their performed suffered.

ABC feedback was logically consistent; commitment had less effect on the cognitive process. In practice this underscores the paradoxical situations where business management may be more resistant to change and innovation in less favorable decision environments, such as direct labor overhead costing allocation systems, than in more productive costing systems such as ABC. Management, organizational, and accounting research frequently report studies showing organizational resistance to change, with its detrimental consequences. Accordingly our results indicate another potential ABC advantage: that information accuracy (ABC) may lead users to be more open to innovative approaches, less unproductively committed to futile strategies, and to be more open to dynamism in the workplace.

To operationalize our research objectives, ABC information and presentation factors were simply built into our study as the straight-forward and objective, dichotomous factors that they are: (1) cost information was calculated and presented as either ABC or traditional, single-driver data, and (2) the information was presented in either graph or numeric, table format.[2] A workable proxy for decision commitment, arguably a more complicated, subjectively measured factor, was achieved by using performance incentives that rewarded commitment to decision strategies. The experimental set-up moved through three levels of decision factor influences, from concrete to the abstract: first the face value of the information alone (ABC & TC), second, presentation format (spatial & symbolic) and third, decision commitment.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Information Content, Cognitive Fit, and Presentation

Although empirical support for the value of ABC information was a motivation for this study, the issues of ABC decision relevancy, information delivery, and effects on information processing are the more challenging, and perhaps interesting issues supporting our study. Our first objective remained, however, to establish that (at least within the confines of our experimental conditions) ABC had significant value, as measured by firm profits. We then interjected two behavioral decision making factors, presentation and decision commitment, both of which had been studied independently in decision theory. The interacting effects of all the combined factors completed the study. We added a second, important and related

response variable to all phases of the study, decision efficiency [time]. Decision time, together with our first response variable [decision outcome/accuracy] define the real-world, practical value of decisions in most circumstances: effectiveness [accuracy] and efficiency [time].

The theory of cognitive fit holds that the mental representation appropriate to problem solution is a key aspect to solution accuracy and efficiency (Vessey, 1991, 1994). Decision outcome is influenced not only by information content (in our case, ABC and TC) but also by presentation mode: the manner in which information is delivered for cognitive processes. Presentation influences the palatability of the information, which in turn governs its efficient use. Information that is relevant to problem solution and is cognitively compatible satisfies the necessary initial steps of efficient mental processing (Vessey, 1991, 1994). This process is known as decision framing. Relevant information, suitably presented, contributes to effective decision framing. Detraction from either the relevance of information or its cognitive-friendliness negatively impacts the decision making process and the decision outcome suffers.

This line of research on cognitive decision processes, and specifically on the presentation effects on accounting information, gained in popularity and importance with the emergence of computing technologies in the 1970s (Simon, 1975, 1981; Libby, 1981; Ashton, Kleinmuntz, Sullivan, & Tomassini, 1988; Remus, 1984; Perrig & Kintsch, 1985; Kleinmuntz & Schkade, 1993; DeSanctis, 1984; Jarvenpaa, 1989; DeSanctis & Jarvenpaa, 1989; Davis, 1989; Anderson & Reckers, 1992; MacKay & Villarreal, 1987; Vessey, 1991, 1994; Benbasat & Dexter, 1985, 1986). The importance of this area continues with widespread Internet usage, network data-availability, database accessibility, and the increasing importance of visual imagery in practically all forms of communications. Research largely centered on the question of whether accounting information is best communicated in spatial or symbolic format. Spatial means pictures and analog processing; symbolic is the more traditional numeric accounting tabular presentations. Financial statements and other accounting information are traditionally presented in symbolic, numeric formats. The user ''reads'' the information, as opposed to spatial-type modes where the user is presented images and processes the information in a more conceptual or abstract process. Much accounting, and certainly economics information, however, seems particularly well suited to graphic, spatial presentation. Internet presentations certainly favor the more visual, graphic mode; our seemingly insatiable need for larger and faster computers is chiefly fed by computer visuals and imagery (certainly not text).

Research showed that the seemingly simplistic question examining graphs vs. tables, disguised the underlying complexity of human information processing, and cognition issues. In short, although much study had been completed through the 1980s, conclusions were not definitive. In some ways it seemed little progress has occurred since Washburne observed in 1927 that users were more accurate in identifying specific values from tables but identified data trends better from graphs.

In 1991, Vessey provided pivotal insight in a paper that used a theory of cognitive fit to bridge the gap between previous, seemingly conflicting graphic/tabular research. Her work achieved pointed to some consistency in explaining the previously seemingly conflicting results. Vessey categorized the tasks in prior presentation studies as being either spatial, symbolic, or both and used cognitive fit to explain how this spatial/symbolic categorization more consistently explained the results of other research.

Her approach held for simple information acquisition and evaluative tasks but not for more complex analytic ones. ''In effect, these studies represent decision-making tasks that are too complex to be addressed by the paradigm of cognitive fit.'' (Vessey, 1991, p. 232) Complexity became confound beyond the limits of her spatial/symbolic cognitive fit theory. She defined complexity as tasks that involved a sequence of subtask decision strategies. They were not amenable to simplistic cognitive fit categorization, or to simplistic presentation fits.

Vessey's theory described task-oriented cognitive fit as the matching of problem representation with appropriate problem solving processing, as shown in Fig. 1. Different tasks are matched better with different mental representations. Cognitive fit affects task performance, which may explain graph vs. table performance. Vessey viewed the mental representation process as symbolizing the way working memory processes data to arrive at solutions. According to her model the characteristics of both the problem and the task reach optimal solutions when these characteristics are

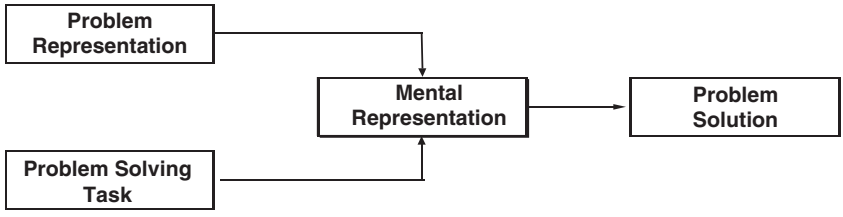

Fig. 1. Vessey's Cognitive Fit Model

harmonized initially. Thus efficiency is achieved when the format of problem representation matches the process required to solve the task. If the representation and the task are not coordinated, translation of the problem representation is first required before processing can occur. This extra step confounds the representation and cognitive processes; distortion and inefficiencies result. Optimal mental representation results when data presentation and task merge without further mental processing.

Vessey borrowed from the psychology literature to categorize data into two fields: images and words. Data exist in working memory as either images or words according to this line of thought. Graphs are images that convey spatial information. Tables are verbal and convey symbolic information. She speculates that spatial representation facilitates "viewing" the overall message/image of graphic information. Graphic presentation provides the best link to human perceptual or basic sensory type processing. Conversely, if identification of discrete data points is necessary for problem solution for simple analytical tasks, then symbolic presentation facilitates solution. So another important delineation of cognitive processing differences is whether they involve perceptual/sensory processing or analytic processing.

Dull and Tegarden (1999) extended the basic graph and table presentations to three-dimensional representations. "It is reasonable to conclude that if one's experiences are from a three-dimensional world, representations on which he or she might make decisions may be understood better in that format." (Dull & Tegarden, 1999). Vessey's cognitive fit explanation seems to coincide well with Dull's observation. Task orientation is probably manifested beyond simply spatial or symbolic representations; it presumably would be sensitive to representation. Dull and Tegarden (1999) found that the most realistic presentation formats (three-dimensional rotatable figures) resulted in greater trend prediction accuracy in a controlled experiment they performed. Cooper (1990) theorized that individuals might unconsciously translate two-dimensional representations into more realistic three-dimensional mental images. If so, this translation involves yet another stage in cognitive processing, and necessarily complicates the process. Thus spatial presentation, especially at the usual two-dimensional level, may itself add a level of complexity (translation to a three-dimensional mental representation) that independently adds to the overall complexity of the problem itself. Presentation format, mental representation, and cognitive processing are all closely related to the first factor of our research (ABC information content) as both presentation and complexity respond to decision commitment and, we theorize, to each other.

2.2. Decision Commitment and Cognitive Dissonance

Directly related to cognitive fit and decision-making processes are issues of cognitive dissonance, decision commitment, and resistance to change. The theory of cognitive dissonance, pioneered by Festinger (1957) posited that conflicting information conflicts with natural human tendencies to seek consistent behavior within them. Inconsistency in decision processes results in a stressful, uncomfortable state, which impedes effective decision-making. Decision commitment is a natural behavioral strategy that influences people to resist change, find comfort in previously accepted decision frameworks, and negatively bias conflicting information. Kahneman and Tversky (1984) showed that people selectively use information in decision making, by tending to select information that conforms to their initial mental representations. Brown, Peecher, and Solomon (1999) Kennedy, Kleinmuntz, and Peecher (1997) have researched this effect with auditors, noting that auditors are confirmation prone, tending to accept information friendly to their positions, and are overly critical of un-supporting data. Haynes et al. (1998) found similar biases, in a specific controlled study of client advocacy. Auditors, in these instances, follow the common human trait of "self-justification." Self-justified commitment reduces decision stress, is safe, comfortable and supports less dissonance. While commitment may lead to resisting pertinent new information, the trade-off between less stressful decision processes and the value of new information may make decision commitment a valuable attribute under some circumstances.

Vessey (1991, 1994) reminds us that cognitive fit is most influential as fit is reinforced; commitment reinforces and strengthens fit. We hypothesized that in our somewhat simplistic, experimental setting, free of the complexities of the workplace or the audit environment, decision makers with higher levels of commitment would exhibit less dissonance in their decision-making, and would perform better overall. Similar to our motivation in studying not only the simple information content effects, but also presentation effects on decision optimality, we were interested in the interacting effect of information content and decision commitment. Again, simplistically decision commitment would seem to reduce cognitive dissonance, improving decision performance. We were interested in how decision commitments might influence performance as the complexity of the decision environment increased.

In some contexts decision commitment is detrimental. Straw (1976) showed that not only would commitment bias decision positions, but that people will tend to escalate their commitment to failing courses of action.

Accounting literature refers to this as the sunk cost trap, which is a major element of popular variable cost decision strategies as taught in most managerial accounting courses. Greenwald, Leippe, Pratkanis, and Baumgardner (1986) refers to a classic study where people are three times more likely to properly identify blurred images given one slightly blurred picture than when people are allowed to view the picture continuously from a very blurred state to the slightly blurred state. Curiously, those given the additional information were much less likely to make correct identifications. The reason is that the additional information was used prematurely, and, importantly, resulted in a committed position. The premature decision, based on poor data, represented a mind-set, a commitment, which then interfered with subsequent effective interpretation of more precise information, and that such a mental commitment may have stronger effects in decision cost strategies, which is an interactive response we wanted to examine in our study.

Decision commitment effects are complicated and can be contradictory. As noted, commitment can reduce cognitive dissonance, leading to positive decision outcomes, contributing to valuable decision-making as we hypothesized in our general, one-effect rule. Commitment may stifle creativity, but creativity does not always lead to the best or most efficient or timely decision-making. Conversely commitment to a poor strategy impedes qualitative analysis and innovative thought, at times presenting persistent barriers to necessary change, which, as Straw (1976) and the audit studies noted, can detrimentally escalate the resistance for necessary change. A delicate and complex balance exists between the efficiency advantages of decision commitment, and the need for diligence and dynamism often countered by decision commitment.

We hypothesized that decision commitment would provide more decision value in the less reliable traditional-costing (TC) information than with ABCs better information. Non-ABC, TC information, is presented as direct labor dollar cost allocations, as is common in single cost driver industrial applications. TC, single-driver information is often misleading and includes more distractions and noise. Decision strategies are more difficult to reliably formulate, the process is more stressful, cognitively dissonant, and uncomfortable. We believed TC information would impede the cognitive fit process. Hence, decision commitment should have a stronger benefit (avoidance of dissonance, decision stress, and frustration) in the TC environment. Commitment will be most influential in the presence of the assumed weaker, less precise TC information. Given that the TC information contains much noise and is often misleading commitment should have a positive influence

in this environment, with the positive effect on decision tranquility offsetting the possible benefits from innovative thought, which would not be of much help in the misleading TC situation.

Put another way, decision strategies in static decision environments that use consistent approaches (commitment), will benefit as the incongruence of the task and information increases. The more chaotic TC information is more incongruent, lending itself to overall positive commitment effects. TC decision feedback is somewhat "off-target," less easily interpreted into solution possibilities. In such situations decision commitment incentives that reinforce commitment influences should be effective for both ABC and TC, but decidedly more helpful in TC. This supports the findings noted above that auditors tend to favor information that self-justifies their (committed) positions, biased perceptions of new information results in less decision stress (dissonance). With ABC, cost information is more interpretable, its merits outweigh commitment's dissonance-reducing value.

The "less is more" paradox fits well with the theory of information overload as well (Vessey, 1994). Decision commitment can reduce apparent decision complexity and streamline decisions. That is, the level of potential complexity-induced decision confounding may vary, depending on the strength of commitment. Higher levels of decision commitment may improve the mental representation process, by filtering out the noise that decision complexity adds. Information noise is higher in the TC environment. The relative influence and value of commitment may change depending on the dynamic influences of other factors. These relationships underscore the importance of studying not just the main factor effects, but their interacting effects, which we predicted would be stronger in the TC environment.

2.3. Hypotheses Development

The research question that fundamentally motivates our research is simple: does ABC work? Firm profits and decision efficiency are the response variables. In addition to the ABC question, presentation and decision commitment are as compelling, more complicated, and perhaps more interesting additional independent factors. We use six hypotheses to test the main effects and two-way interactions for each of the two response variables.[3] To simplify the discussion of hypotheses, and because the response variables are strongly related in terms of decision value, the six hypotheses for each response variable (profits and time) are presented as one set of six (rather than 12) hypotheses.

The following three main effect hypotheses are straightforward, requiring no further discussion:

H#1. ABC information provides better information for decision-making than TC methods.

H#2. The format of information presentation, graphic (spatial) or tabular (symbolic), will have an effect on decision-making.

H#3. Decision commitment will have a positive effect on decision-making.

The following three interacting hypotheses are more complicated; they are followed by additional supporting discussions:

H#4. Presentation format will affect information processing differently depending on the congruence of the information with the problem solution (ABC vs. TC).

Problem solving is task oriented. Problem solving may be facilitated by presentation in either spatial or symbolic format. ABC information is more relevant to the problem solution, but it can be more complex than TC information. This additional information may or may not be processed more effectively through spatial or symbolic representation. Since the ABC information is more accurate, it should permit a more straightforward strategic analysis. TC information contains noise that tends to confound internal analysis. The TC clouding of information interrupts efficient mental representation and cognitive fit suffers. The interaction of content and presentation should show different responses as each is varied with the other. ''Cognitive cost'' should manifest differently between these two factors.

ABC information may present the most clear decision mental representation in the simplest of presentation modes (numeric), but numeric presentation may be less valuable for interpreting trends. The effect on TC information may be directionally similar, but of greater magnitude as the presentation mode changes. This is consistent with Vessey's (1991, 1994) mental representation, decision framing, and cognitive fit theories, Benbasat and Dexter's (1985) information overload theory, Davis' (1989) cognitive efficiency theory and Jarvenpaa's (1989) cognitive cost theories.

H#5. Decision commitment will have a more positive effect on TC decision-making than on ABC decision-making.

The decision problems presented are static. Effective solution requires comprehension of cues provided by the ABC or TC information after repeated trials. Decision commitment should be more helpful in deciphering the less accurate TC information than it will for the ABC information. Subjects are likely to be more prone to inconsistent, cognitively dissonant behavior using the confusing, less-reliable TC data. Decision commitment should be of the most benefit in this cluttered environment. The static, repetitive nature of the decision environment encourages the discipline that decision commitment adds to the analytic process, most positively where information cues are more frustrating.

Decision commitment should aid in providing a level of reference or consistency to help in analyzing the less relevant and less accurate TC feedback. The more relevant and accurate ABC information is not expected to benefit as much from commitment, following the reliably consistent ABC information is not a confounding experience. While commitment may be beneficial to both ABC and TC, it should be significantly more helpful to TC. The "cleaner" cognitive fit provided by ABC information is expected to be less affected by the positive influence of commitment.

H#6. Presentation format will affect performance differently depending on the strength of decision commitment present.

Spatially oriented subjects may be helped more through the positive effects of decision commitment because of the complexity of the graphic visualizations, than subjects for whom complex visualizations are more challenging to process. Presumably decision commitment will have a greater magnitude in effect for the mental representations afforded by visual graphics vs. numeric listings. The effects on performance in this static, analytic problem of repeated trials should be greater for one visualization than another.

3. METHOD

3.1. Experimental Design

The hypotheses were tested using a $2 \times 2 \times 2$ mixed-factor experimental design structured for ANOVA.[4] The underlying experimental condition of the study, ABC information, was between-subjects. The other two conditions, presentation and commitment, were within-subjects. The mixed-factor design divided the 48 participants into two groups, ABC and TC information

only. Within each group participants repeated the experiment four times, representing the four possible combinations of the two crossed conditions (presentation and commitment). Crossed conditions were completely counterbalanced.

We developed a computerized, interactive business simulation that incorporated our three experimental conditions of interest. The simulation was a model of a profit-oriented business in which the participants' objective was to maximize profits. Participants made product volume decisions to maximize profits. They were offered incentives to maximize their game performances relative to other players. (Real money, with an expected value of $25 per player and extra course credit.)

The game was completely automated and player-interactive. Other than brief introductory greetings by the experimenter, players interacted one-on-one with the computer game, including game instructions. Computers were located in small individual cubicles in a behavioral lab. The computer automatically dispersed game instructions, collected demographic data, started each game at the players' prompting, ran the games, recorded detailed results of each game, and exited the program at the end of the games. The game utilized Microsoft Excel as a computing platform, using Excel's Visual Basic programming capability to automate the process, and to change the computer screen from the standard Excel format, to an attractive, colorful video game. Player choices and game play was completely controlled by the computer.

Players were accounting major volunteers that had completed their first two accounting principle courses, and two introductory computer courses required of accounting majors. Completion of the four simulation games plus an abbreviated preliminary practice game took the players about 2 h. The combination of the high potential player rewards ($100), the competitiveness of the situation, and the attractive computerization and video game atmosphere made the game interesting to the participants. At the completion of the experimental session, players were given two, 2 min spatial ability tests.

3.2. Decision Task, Game Mechanics, and Computerization

Players were told they were in the baseball equipment business. They had four baseball products (bats, balls, gloves, and pitching machines) for which they set production levels, which could vary from zero to large numbers of units. Demand was infinite and prices were fixed, eliminating the complexity of interpreting demand effects: cost analysis was the objective. Costs were

governed by eight production functions, six of which were overhead. Half of the overhead functions were complex, non-linear functions, which were further complicated by volume interrelationships; production of one product affected the costs of other products. The cost structure of the game mimicked real business to the extent practical.

3.3. Operationalization of Experimental Conditions

Factor one, availability of ABC information was operationalized as a dichotomous variable where ABC information was either available or not. For ABC participants the cost information was displayed in eight lines of information: material, direct labor, and six overhead costs. The non-ABC, TC players got three lines of cost information: material, direct labor, and one overhead cost line. The ABC costs were assigned based on cost pool activities. TC costs were assigned on a direct labor dollar basis. Total overhead cost for all production combined was identical regardless of ABC/TC cost assignment. Cost assignment among the four products were, however, not identical. ABC assignments were more accurate. Regardless of cost assignment, total business costs and profitability were identical given identical production input decisions.

Factor two, presentation of cost and profitability information, was a within-subjects variable. Summary financials were given numerically regardless of the presentation condition, but the detailed product cost and profitability information (ABC or TC) was given either in graphic or tabular format. The graphs were simple bar charts.

Factor three, commitment, was also within-subjects. Commitment was injected into two of the four games that participants played. The operational design of the commitment condition was simple: two games included commitment and two did not. While graphs and ABC information were simple categorical conditions that were easily operationalized, the introduction of commitment was more complex. To establish decision commitment additional monetary incentives were used as a means to force a "decision commitment effect." Players assigned to this commitment condition were told that if their verbalized (written, for added reinforcement) strategy was correct, and they stayed with it, they would receive an additional $25 bonus for that game. The interactive game also informed them that if they met these conditions it would probably turn out that they had the best results in their group of eight so they would win the $100 top prize as well. The players that were not assigned the commitment condition were told to verbalize their strategy as well but were offered no additional monetary incentive.

Wicklund and Brehm (1976) and Church (1990) concluded that decision commitment is stronger when people verbally commit to a position and when they choose that position themselves. Accordingly players were instructed to input their decision strategies about halfway through each game. The bonus serves to intensify the commitment effect and thereby differentiate the commitment group.

4. RESULTS

4.1. Overall Findings

The ABC condition and the decision commitment condition influenced profits significantly. The ABC factor had a p-value of 0.002, which supports the basic premise of the research that ABC provides relevant decision-making information (Hypothesis #1). Profitability response variable results were also significant for the commitment condition (Hypothesis #3) and the ABC/commitment interaction (Hypothesis #5). The presentation condition was not significant for the profit response variable. Presentation did, however, significantly affect decision time (Hypothesis #2). Decision time was not significantly affected through any other conditions, which is to say that decision times were effectively the same under all conditions, except for changes in presentation format. ANOVA results are shown on Table 1.

All significant profitability results (information content, decision commitment, and the information content/decision commitment interaction) had no discernable time differences. This particular combination of profitability results for the factors other than presentation, with significant timing results for presentation only, is not a set of unrelated, mutually exclusive outcomes. Their particular combination of results complements each other well, and provides additional confidence in the overall experiment design. Put another way, a different combination of results might have implied that the model simply did not pick up some effects adequately because of poor design. These results, one pattern of effects for one response variable and a complete reversal of effects for the other response variable, indicates the model in fact differentiated well. (Complimentary results are discussed below.)

Further, all of the significant differences represented meaningful, practical differences. For example, Table 2 shows that the significant time differences for presentation were 1.6 min of 17 min total (10%), and the significant profitability differences were hundreds of thousands of dollars (over an average profitability range of, at most, $1.2 million). Table 2 presents the

Table 1. ANOVA Results.

	Response	Df	Mean Squares[a]	*F* Value	*P* Value
Hypothesized Effect:					
#1: Information content – (ABC/TC)	Profits	*1*	*7.0 E+13*	*10.45*	*0.002*[a]
	Time	1	1.75	0.03	0.866
#2: Presentation – (Graph/Table)	Profits	1	6.5 E + 11	0.08	0.778
	Time	*1*	*127*	*5.06*	*0.029*[a]
#3: Decision commitment (Yes/No)	Profits	*1*	*6.7 E+12*	*6.15*	*0.017*[a]
	Time	1	8.49	1.65	0.206
Interactions:					
#4: Info. content & presentation interaction	Profits	1	7.5 E + 11	0.09	0.763
	Time	1	1.86	0.07	0.787
#5: Info. content & decision commitment Interaction	Profits	*1*	*5.7 E+12*	*5.18*	*0.028*[a]
	Time	1	3.68	0.71	0.403
#6: Presentation & decision commitment interaction	Profits	1	7.3 E + 11	0.49	0.489
	Time	1	4.5	0.43	0.514

Note: Response variability for *profits* was large, as evidenced by large mean squares. The large variances account for the reason that some seemingly large differences in average response (Table 2) were not significant.

[a]Significant differences (at $P < .05$) are shown in italic.

average profitability and elapsed time results for all significant differences. Player response ranges, and accordingly, the related variances were large.[5] Hence, significant differences tended to be meaningful on a practical as well as statistical level.

The game was discriminating in awarding profits, but had low tolerance for inputs outside its optimal operating ranges. Accordingly losses were common and sometimes high. We believed that this somewhat narrow range of profitability approximated true industry operating ranges, the elusive ''sweet spot'' where profits are maximized, outside of which results are disappointing.

4.2. Testing ABC Information Value

As predicted, players had better simulation profits when provided with ABC information than when they were given TC information. Average profits for the ABC players were $213,038; the TC players lost an average of $991,787. These differences were significant at $p = 0.002$.

Table 2. Average Results by Experimental Conditions (See Table 1 for Mean Squares and Significance Levels).

Experimental Condition	Profits Earned	Time: Minutes
ABC information	$ 213,038[a]	17.0
TC information	(991,787)[a]	17.2
Graph presentation	(447,584)	17.8[a]
Table presentation	(331,164)	16.2[a]
Decision commitment present	102,246[a]	9.1
No decision commitment	(271,670)[a]	9.5
Interaction – information & decision commitment[a]:		
ABC: No decision commitment	157,790	9.6
With decision commitment	188,548	8.9
TC: No decision commitment	(701,131)[a]	9.2
With decision commitment	15,944[a]	9.4
Average for all conditions – complete games	$ (389,374)	17.1

Note: Averages are calculated based on full game results (years 2–12 less worst) except for decision commitment conditions and Interactions which covered years 6–12 less worst.
[a]Denotes significant effect – (at 5%); *t*-test on ABC interaction component (profits), $p = 0.38$; *t*-test on TC interaction component (profits), $p = 0.034$; *t*-tests for time showed no significance for any of the interaction components.

It took essentially the same time to make decisions (17.0 vs. 17.2 min per game). This lack of difference could be a fault of the model design; it could simply be that while ABC contained more information, that information was more clear and easier/faster to process, or it could be a result of other offsetting influences, which are difficult to speculate about. While we speculated that ABC information to take more time to process, as we have noted, the fact that it did not, we believe, precludes the position that ABC might have performed better (in profits) resulting form more participant analytic decision time, rather than because of the superior ABC information content.

4.3. Information Presentation: Graphic vs. Tabular

Graphs took significantly longer to interpret than tabular presentations, but both presentations yielded similar game results. Graphs took an average of 17.8 min vs. tables, which took 16.2 min ($p = 0.029$). Cognitive processing of analytic information is task oriented. We did not predict whether task orientation would favor spatial or symbolic framing.

The experimental results indicate that graphic presentation added steps to mental processing rather than streamlined or focused processing. It took longer and more effort to arrive at solutions given graphic input, but the eventual solution was the same regardless of presentation format. We might contemplate that had we limited or fixed the decision time allowed, participants would have significantly worse profits under the graphic condition, however, we did not test for this.

The difference in average profits between graphs and tables was $116,420. (A loss of $447,584 for graphs vs. a loss of $331,164 for tables.) While the monetary difference appears large, the variances between individual players and games were sufficiently large that they were not significant (see note 5). We can take some comfort in the fact that the direction – unfavorable for graphs – is consistent with the direction of the time effect, indicating that graphs were the poorer overall medium, which seems to be consistent with the extra time needed to work with the graphs.

4.4. Decision Commitment: Present or Not

The decision commitment condition was based on sound theoretic hypotheses but was an ambitious (and perhaps risky) operationalization. It was therefore rewarding to find that commitment did significantly affect the quality of decisions (profits). Importantly, the direction of differences, and the positive interaction effects (discussed below) supported the theory our predicted results indicated.

Players that were influenced to commit to decisions made better use of the game information and made better decisions. It took them no longer to make these better decisions. The lack of elapsed time differences is important. As noted elsewhere it gives additional theoretic support for the hypothesized commitment results, just as it additionally supported the information content (ABC/TC), results, and conclusions. Since decision time was (statistically) the same for the committed and non-committed conditions, and all other factors were strictly controlled at the same levels, the significant profitability results can be attributed to differences in commitment. Had decision time been more (or perhaps less) for the committed participants, additional decision time could not have been ruled out as the reason for the significantly better profits, and not necessarily the commitment level. This was not the case, which strengths the case for commitment causing better decision performance.

The more positively committed players made average profits of $102,246. The uninfluenced players lost $271,670. It took 9.1 min for the positively influenced players to make their decisions vs. 9.5 min for the uninfluenced.

Execution of the commitment condition included a monetary incentive that was not offered to the "non-committed" players. This situation invites the speculation that observed differences could be the result of motivational changes resulting from differing monetary incentives and not because of the desired commitment condition. Had the profitability differences been due to monetary incentives and motivation, however, one would expect that the financial incentive would have similarly motivated a more serious game approach that would have resulted in those players spending more time attempting optimization. That did not occur. Once again, the time-result, or lack of difference provides comforting negative assurance supporting our other, statistically significant findings.

If we take the position that time spent is a reasonable proxy for motivation, then we can infer that players with the commitment incentive were no more motivated that the non-incentive players. Further, the variances for the commitment incentive group were much smaller than the group without the incentive. Standard deviations were $ 202,337 for the incentive group vs. $1,654,584 for the non-incentive group. Smaller variances support successful implementation of the commitment condition. Decision commitment was designed to influence players to adhere to preliminary strategies in working toward final solutions. The fact that their decisions were better, their variances smaller, yet their times were the same provides further evidence of successful commitment operationalizations.

4.5. Interactions

Main effect analyses showed strong, favorable profitability effects for ABC information and commitment. The interaction between these two factors was also significant. Decision commitment helped the TC information group substantially more than commitment helped the ABC information group. Graphically the interaction effects are shown in Fig. 2.

These stronger TC and commitment effects were predicted. Although the profitability and cost functions changed from game to game, within each game (12 years of play) these functions remained exactly the same. Successful strategies were those that used yearly feedback to understand overhead cost functions. Commitment was valuable as it added focus to the process. In the ABC environment the focus was of some incremental value (average profits moved from $157,790 to $188,548 under the added influence of commitment) but not substantially so. In the more chaotic, less predictable TC environment, players had a more difficult time understanding overhead cost behavior. In this situation the focus that the commitment

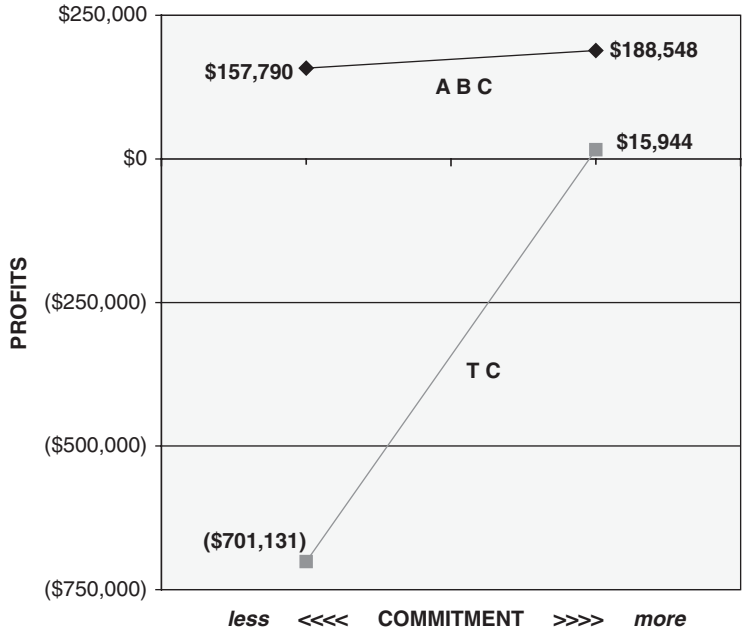

Fig. 2. Interaction Effects: Cost Information and Commitment

influence brought to the player's analysis was very helpful. Average profits went from a loss of $701,131 to a gain of $ 15,944.

Consistent with other findings, interaction decision times did not vary significantly from interaction condition to condition. As we discussed, this result strengthens the argument supporting successful commitment operationalization, in context with the significant findings for the profit response variable. Because decision times were essentially equal from condition to condition it seems that players were similarly motivated (but not similarly committed). It was decision information type and commitment strength that appeared to directly affect decision performance (profits), and not motivational differences. Commitment framed the decision but did not seem to add much motivational incentive (as measured in time elapsed).

The commitment condition was introduced after year five. The average times to complete games 6–12 (less the longest) were from 8.9 to 9.6 min. Interestingly in both the ABC and TC cases the non-commitment condition required more time (although not significantly more) on play, again at least intuitively supporting the success of the commitment condition vs.

motivational proxies. The other two interacting conditions, ABC/Presentation, and Commitment/Presentation, showed no significant profitability or time differences.

4.6. Covariance Analysis and Demographics of Participants

We collected information on eleven demographic variables and independently tested participant spatial abilities using standardized tests. We expected some covariate influences on items such as SAT and certainly on spatial ability for the presentation factor. As it turned out covariate variables were not influential. Using the commitment data, only two covariates approached significance. Spatial ability had a significance level at $p = 0.13$ and sex had a covariate value of $p = 0.15$.

5. CONCLUSIONS

Our study provides empirical evidence that ABC information adds analytic value to profit-oriented decisions in a controlled setting. Further supporting ABCs decision value, ABC information, although more detailed and complex, did not require more decision time. Our empirical support compliments industry, accounting and academic literature, which, although not without its detractors (as noted in our introduction), is overwhelmingly favorable to ABC methods. Further, our decision commitment findings support the argument that ABC methods may support the open, innovative, receptive decision environments favorable to today's dynamic business settings.

Intuitively ABC appears unchallengeable in providing more relevant information from which important, profit-dependent decisions can be made. To date, descriptive research seems to favor ABC. Yet, as we note ABC backlash remains. While this study may not convince the critics, we can at least say that, under the more pure decision environments afforded by laboratory conditions, people make far better decisions using ABC information, and do not appear to require more time to use the additional ABC information. Decision commitment, while not important to the efficacy of the ABC decision process, benefits the less reliable, TC cost information in decision accuracy. Finally people take longer to decipher graphic information in this setting than tabular information, although regrettably we could not discern presentation formats that favored decision accuracy in our model.

While our model did not reveal presentation effects for decision profits, the presentation/time results, that graphs took longer to arrive at essentially the

same profits, is interesting and complements our other findings well. As we explained this combination of findings, positive profitability findings for ABC information, with no time differences, taken together with the lack of profitability differences for presentation, but with time differences, complement each other well and support the validity of the model. Had ABC required more time, it might have been the time and not the ABC information that yielded the better profit results, and had there profit differences in the presentation mode, interpretation of the time differences would be less conclusive. (Of course, we would not have objected to complimentary time and profit findings.)

Our decision commitment finding broadens our understanding of the importance of mental representation variations in the decision processes. It was particularly satisfying that our commitment factor had the most beneficial profit influences under the more chaotic decision environment offered by the TC condition. That interaction effect supports the hypothesized main effect conclusions for both ABC and commitment. Commitment was most beneficial in the less structured TC environment, with ABC information effective enough that even positive focusing and commitment influences seemed to not have much impact. As a result we have a greater appreciation for ABC accounting environments, that decision commitment plays a lesser role in such environments. ABC might have value in supporting a more innovative and reactive work environment, rather than supporting work environments married to unproductive or futile strategies. In more chaotic, less meaningful cost information settings, however, commitment to a course of action or decision strategy may provide value in which it reduces the stress or cognitive dissonance associated with conflicting information. The conclusion could be that better ABC cost systems, lead to less confusion, more decision confidence, and more openness to innovation and lines of thought. ABC has value in apparently not rewarding commitments to possibly unproductive courses of action, leaving the decision environment more open to change, as is characterized by the increasingly dynamic business environment of today.

Our research was limited such that although the model was effective in capturing presentation differences, as evidenced by significant time differences, it was not sufficiently robust to capture decision quality differences. Perhaps another presentation mode would, at least when interpreted by covariance for spatial ability, affect decision quality as well. Cognitive fit theory would predict synergistic findings for decision time and quality across experimental factors: longer decision time (for one factor of interest relative to another) implies involving a more complicated decision process, inferior cognitive fit, and poorer decisions. Apparently our model was not adequately selective to elicit such responses.

Had we constrained decision time in our model, it seems reasonable to conjecture that presentation differences would have manifested themselves in decision quality (profits), which suggests interesting insights, and the potential for alternative future inquiries. We were surprised that covariate effects, especially for spatial abilities, were not very influential. Perhaps this too was a reflection of the design of our presentation factors. More work in investigating presentation alternatives, perhaps coupled with research on spatial ability performance, could result in a more effective presentation design vehicle for further studies.

In addition to exploring the presentation design issues further, future research could investigate group decision dynamics by measuring the quality and time differences for groups playing the simulation. We believe time differences might prove to be of special interest in group settings. Cultural differences among group play might also be interesting. Further study might work with mental representations in more depth. The effect of decision confirmation on mental representations, and decision-making could be explored by extending the simulation to force preliminary decisions on participants that are given inadequate or misleading information. Presentation factors and related decision factors remain rich ground for future work.

NOTES

1. Horngren, Datar, and Foster (2002) Horngren et al. (2002) and Kaplan and Atkinson (1998) are but two of many well-known managerial accounting texts, each with lengthy sections explaining and endorsing ABC methods. While we know of no college managerial accounting texts that do not have ABC sections, perhaps some do not. Horngren et al. (2002) cites eight recent surveys documenting ABCs popularity in industry. ABCs popularity is similarly evidenced by numerous articles in business periodicals and journals. A recent search of our university database found 547 such articles.

2. We did not hypothesize the three-way interaction as it presented complicated relations about which we had little confidence.

3. Large variances notwithstanding, the ANOVA results were very significant; ANOVA analyses are notoriously robust to such large variances without compromising its "equal variance" assumption.

4. As was hypothesized and found to be true, the response variables were highly correlated. We ran MANOVA analyses, but they provided no new information or insights beyond that obtained from the standalone ANOVAs.

5. Large variances notwithstanding, the ANOVA results were very significant; ANOVA analyses are notoriously robust to such large variances without compromising its "equal variance" assumption.

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