The Effects of Sunk Cost and Project Completion on Information Technology Project Escalation

Mark Keil, Duane P. Truex III, and Richard Mixon

Abstract—**Information technology (IT) projects can fail for a variety of reasons and in some cases can result in considerable financial losses for the organizations that undertake them. One pattern of failure that has been observed but seldom studied is the runaway project that seems to take on a life of its own. Prior research has shown that such projects can exhibit characteristics of the phenomenon known as escalating commitment to a failing course of action. One explanation of escalation is the so-called sunk cost effect which posits that decision-makers are unduly influenced by resources that have already been spent and are therefore more likely to continue pursuing a previously chosen course of action. A competing explanation, labeled the completion effect, holds that decision makers escalate their commitment as they draw closer to finishing the project.**

In order to understand more about the relative effects of sunk cost and project completion information, a role-playing experiment was conducted in which business students were asked to decide whether or not to continue funding an IT project given uncertainty regarding the prospects for success. Three variables were manipulated in the experiment: the level of sunk cost, degree of project completion, and the presence or absence of an alternative course of action. Results showed that subjects' willingness to continue a project increased with the level of sunk cost and the degree of project completion, but that subjects were more apt to justify their continuation on the basis of sunk cost. As theory would predict, the presence of an alternative course of action had a moderating effect on the escalation that was observed.

I. Introduction

RUNAWAY information technology (IT) projects—those that exhibit 2–3 fold (and higher) overruns in project schedule and/or budget—represent a type of IT failure that can cost firms millions of dollars. While such projects have been frequently reported in the press [9], [31], [39], this phenomenon has received relatively little attention from information systems researchers. The IT literature on software project management suggests that significant cost and schedule overruns occur quite often [3], [4], [10], [13], [15], [46]. How can we explain them?

One possible explanation holds that cost and schedule overruns result from a tendency among software developers to underestimate the scope of software projects [10]. Other possible explanations that have been offered include: Inadequate cost estimation models [13], [30], and failure to manage the risks associated with IT projects [5], [6], [21], [27], [32], [33], [41].

While all of these explanations have some merit, they ignore certain psychological and political factors that may be associated with many runaway IT projects. Recent studies have suggested that these variables represent an important, but understudied, dimension of runaway projects [28], [29], [40]. Specifically, it has been suggested that some of these IT projects may represent what can be described as *escalating commitment to a failing course of action* [12]. Escalation has been defined as continued commitment in the face of negative information about prior resource allocations coupled with "uncertainty surrounding the likelihood of goal attainment" [12]. Project escalation can therefore be said to occur when there is *continued commitment* ***and*** *negative information.*[1]

One explanation for escalating commitment is the so-called sunk cost effect in which a decision maker is swayed by the previous investment of resources. A competing explanation, labeled the completion effect, holds that decision makers escalate their commitment as they draw closer to finishing the project. This paper describes the results of an experiment in which sunk cost and completion level were manipulated jointly to determine their effect on subjects' willingness to continue an IT project.[2] A third variable, the availability of an alternative course of action, was introduced as a means of studying one strategy which has been proposed to reduce project escalation.

The remainder of the paper is organized into six sections: First, we review the financial literature concerning sunk costs along with earlier experiments exploring sunk cost effects. We then present our research questions and hypotheses, followed by the methodology used in the experiment. The results of the experiment are then discussed followed by conclusions and directions for future research.

II. Literature Review

Contemporary financial theory suggests that sunk costs should not be considered when deciding whether to abandon or continue a project. Rather, the decision should be based on net present value or other measures of future cash flow streams [11], [16], [20], [23], [35], [36]. Empirical evidence, however, suggests that decision makers find it difficult to ignore sunk

Manuscript received March 15, 1994. Review of this manuscript was processed by Editor E. Geisler. This work was supported by a grant from Georgia State University's Research Enhancement Program.

The authors are with Georgia State University, Department of Computer Information Systems, College of Business Administration, Atlanta, GA 30302-4015 USA.

IEEE Log Number 9414510.

[1] Escalation does not necessarily imply an increasing rate of investment over time, but rather, refers to a growth in the cumulative amount of resources invested over time. Thus escalation can be thought of as continued commitment.

[2] An earlier analysis of some of the data from this experiment was presented and discussed in [29].

costs [7], [17], [34], [44]. While one can debate whether this so-called sunk cost effect represents a deviation from rational decision-making, the important point is that the effect does appear to exist and can be quite influential [43].

A. Empirical Evidence Regarding the Sunk Cost Effect

Arkes and Blumer [7] conducted ten separate experiments designed to test the sunk cost effect in a wide variety of decision contexts. Most of their experiments required the subject to read a one-paragraph scenario and then make a decision. One experiment, for example, involved an R&D investment in a defense aerospace project. Based on the result of this and other experiments, Arkes and Blumer concluded that sunk costs can influence decision makers.

Further work by Garland and his colleagues [17]–[19] investigated the same phenomenon. Garland and Newport [18] studied the effects of absolute and relative sunk costs on the decision to continue with a previously chosen course of action. Using a latin square design, they investigated the effect of two independent variables, absolute and relative sunk costs, on the dependent variable which was subjects' "probability of using all of the remaining funds in a budget to complete some course of action" [18, p. 55].

Absolute sunk costs were expressed as dollars expended in relation to the total amount budgeted, whereas relative sunk costs were expressed as the percentage of the total budget already spent. Using two different levels of absolute sunk costs and two different levels of relative sunk costs, four different versions of each scenario were developed representing all possible combinations of absolute and relative sunk costs. The results suggested that "relative rather than absolute magnitude of sunk costs had a significant impact on subjects' reported likelihood of committing additional funds to some action" [18]. These findings were judged to be consistent with a prospect theory [25], [26], [45] interpretation of the sunk cost effect.

While the Garland and Newport study found strong evidence of the sunk cost effect, their dependent measure was based on the likelihood of committing *all* remaining funds in the budget, an amount which varied across different treatment groups. Because of this, the results obtained in their experiment may have been due to a rational consideration of the cost required to complete a project rather than to the sunk costs already incurred [17]. A subsequent study by Garland investigated this possibility [17]. In this study, Garland investigated the difference between incremental (constant) versus "all remaining funds" investments. In this experiment, Garland saw "no indication that incremental costs played any role in decision making" [17, p. 728]. Rather, he observed a linear sunk cost effect based on the percentage of budget invested, a result that was consistent with previous studies.

B. Sunk Cost or Completion Effect?

Based on the above studies, the effect of relative sunk costs on the tendency to escalate *appears* to be robust and reproducible, regardless of whether escalating commitment is measured in incremental (constant) terms or "all remaining funds." In a subsequent study, however, Conlon and Garland have questioned whether the so-called "sunk cost effect" might actually be caused by some type of "completion effect" in which the "motivation to achieve a goal increases as an individual gets closer to that goal [14, p. 403]."

TABLE I
MEAN LIKELIHOOD OF CONTINUING THE PROJECT [14]

Sunk Costs	Degree of Project Completion			
	No Information	10%	50%	90%
No information	59.77	63.33	65.78	73.00
$1 million	64.32	56.97	59.84	66.11
$5 million	69.11	58.16	70.62	76.00
$9 million	66.49	60.69	59.82	74.57

These authors observe that in previous studies, sunk cost and completion level have been jointly manipulated (i.e., subjects have been informed that x% of the budget has been spent and that the project is x% *complete*). By confounding the two factors in this manner, it is difficult to say with certainty whether the escalation that was observed in previous studies is due to sunk cost or the completion effect. Conlon and Garland argue that while there may be a "... strong positive correlation between sunk costs and project completion ... they represent theoretically different concepts that may contribute separately to continuing investment behavior." [14, p. 403].

In an attempt to resolve this issue, Conlon and Garland conducted a study in which there were four levels each of sunk cost and project completion variables and two levels of competitor information. The experiment was similar to previous studies except that: 1) sunk cost and completion were manipulated independently and 2) half of the subjects were led to believe that the competition represented a serious threat while the other half were led to believe that the competition did not represent a serious threat. Since the competitor information was not found to interact with the other manipulations, Conlon and Garland reported the results for all combinations of sunk cost and project completion collapsed across competitor information, as shown in Table I. The results of this and another similar experiment conducted as part of the same study, *seem to suggest* that the escalation behavior is largely driven by the completion effect rather than sunk cost. But is this so? One of the purposes of this paper was to further investigate the relative impact of sunk cost and completion information on the decision of whether to continue or abandon a project. Another purpose was to investigate the notion that the existence of alternatives can decrease escalation.

C. Escalation Behavior in the Presence of an Alternative Course of Action

Whether escalation behavior is driven by sunk cost, completion effect, or other factors, it is important to experiment with strategies for minimizing escalation. One such strategy may be to encourage decision makers to consider any feasible alternatives before deciding to continue a project that may be in trouble [42]. A study conducted by Northcraft and Neale suggests that decision makers are less likely to exhibit escalation behavior when the opportunity costs of continuing with a particular course of action are made explicit [34].

Using different case scenarios involving a real estate development project gone sour, Northcraft and Neale created two experimental conditions: One in which there was no mention of opportunity costs and one in which subjects were reminded that they could divert the funds needed to complete the project to one of two investment opportunities. Using a repeated measures design with 20 subjects, they found that subjects were more likely to abandon the project when opportunity costs were made explicit.

While the results of the Northcraft and Neale experiment are intriguing, there were several limitations in their methodology. First, the same subjects were exposed to both treatment conditions, thus raising the question of whether exposure to the first case scenario influenced subjects' responses to the second scenario. A second limitation is that the sunk costs were manipulated at a single, relatively low level (29%). Since subsequent studies have shown that higher levels of sunk costs produce stronger effects, making opportunity costs more salient may not have the same effect at higher levels of sunk costs.

In this research, we sought to combine the best elements of both the Garland [17] study and the Northcraft and Neale [34] study while compensating for weaknesses in these studies.[3] Our purpose was both to replicate and extend previous work conducted by these escalation researchers and to investigate whether sunk cost and completion effects could be observed in an IT context.

III. Research Questions and Hypotheses

In light of the considerable investment firms are making in IT and the detrimental impacts that runaway projects can have, we were interested in examining three questions:

1) What effect, if any, do sunk cost and project completion have on a decision maker's willingness to continue funding an IT project?
2) Does the presence or absence of a clearly defined alternative course of action have any impact on how a decision-maker responds to different levels of sunk cost and project completion?
3) Is escalation behavior driven more by sunk cost or by the completion effect?

Consistent with Question One, the first hypothesis concerns the applicability of the sunk cost effect in the IT domain.

H1: Willingness to continue with an IT project will be positively correlated with level of sunk cost and degree of project completion.

H1 follows from the work of Arkes and Blumer [7], Garland [17], [18], and Conlon and Garland [14] provided that the escalation observed in previous studies is transferable to an IT context. Previous studies have shown that decision context can make the difference between whether or not escalation is observed [19]. This study seeks to determine whether the sunk cost or completion effects exist within an IT context, and if so, under what circumstances.

[3]The design and methodology section discusses in more detail some of the limitations of previous studies and the steps that we have taken to address these issues.

Consistent with Question Two, the second hypothesis concerns the effect of an alternative course of action on escalation behavior.

H2: Regardless of sunk cost and completion level, subjects will exhibit less willingness to continue with a prior course of action given the presence of an alternative course of action that appears equally attractive.

H2 follows from the work of Northcraft and Neale [34] and is consistent with a framework proposed by Staw and Ross [42] for explaining the determinants of escalating commitment.

Consistent with Question Three, the third hypothesis concerns the relative impact of sunk cost versus completion information in explaining *why* escalation occurs.

H3: In the presence of both sunk cost and completion information, subjects who escalate their commitment to a project will more frequently justify their action on the basis of completion, or proximity to goal, as opposed to sunk cost, or the amount of resources already expended.

H3 follows from the recent work by Conlon and Garland [14] in which the completion effect was judged to be more important than the sunk cost effect in explaining escalation behavior.

IV. Design and Methodology

A laboratory experiment was selected as the most appropriate methodology for addressing our research questions. This approach, which is consistent with previous studies of escalation and the sunk cost effect, allowed for a high degree of control and enabled us to readily test specific hypotheses. The subject pool consisted of 322 undergraduate business students enrolled in an introductory information technology course at a large urban university. Participation was voluntary and 313 students agreed to participate by signing an informed consent form, resulting in a participation rate of 97.2%. The mean age of the subjects was 25 (s.d. 6.5) and the mean work experience was 7.2 years (s.d. 5.8). While the level of work experience may seem unusually high for college students, it reflects the population from which our sample was drawn: A student body that is largely comprised of undergraduate students who work full-time.

While the choice of students may limit external validity [22], [24], there were several reasons for taking this approach. First, the literature suggests that the nature of the experiment itself is an important factor in determining whether or not students are an appropriate choice for subjects. From the standpoint of external validity, there is some support for using students as surrogates for managers, particularly when the tasks being studied involve human information processing and decision making [8] which was certainly the case in this situation. Second, since we were interested in knowing if the escalation observed in other decision contexts could be replicated in an IT context, we wanted the other conditions in this study to match those used in prior research so as to avoid introducing additional sources of variance. Therefore, since previous laboratory experiments on escalating commitment have used students as subjects we chose to do so as well.

The experiment described in this paper involved different versions of a short case scenario in which subjects were

TABLE II
DIFFERENCES BETWEEN OUR EXPERIMENT AND GARLAND'S [17] EXPERIMENT

Key Differences	*Garland's [17] Experiment*	*Our Experiment*
Decision Context	Defense aerospace R&D project	IT project to develop software product for external sale
Independent variable(s) investigated	Level of sunk cost and degree of project completion (manipulated jointly)	Level of sunk cost and degree of project completion (manipulated jointly) and presence/absence of an alternative course of action
Parameterization of sunk cost and completion level	Five levels (10, 30, 50, 70, and 90%)	Four levels (15, 40, 65, and 90%)
Type of data collected and analytical tools used	Quantitative data; statistical analysis	Quantitative and qualitative data; statistical analysis and content analysis
Manipulation check	No	Yes
Treatment of Time	Not controlled for—possible confounding factor	Controlled to avoid a possible confounding factor

asked to play the role of the president of a small computer software company. The scenario involved a software product that was being developed for external sale and was based on a defense aerospace R&D project scenario developed by Arkes and Blumer [7] and later adapted by Garland [17].

In addition to placing the scenario within an IT context, we chose to further extend Garland's work by introducing an additional independent variable, namely the presence or absence of an alternative course of action. As indicated in the Appendices, we created two scenarios: One that contained an alternative course of action (Appendix B) and one that did not (Appendix A). In both cases, sunk cost and completion levels were manipulated jointly (i.e., subjects were informed that the project was x% complete, where x matched the sunk cost level expressed as a percent of budget). After receiving the sunk cost and completion information, all subjects were told that another firm had just started marketing a similar software package that was reported to have more functionality and greater ease of use. In the "with alternative" scenario, however, the subject was further informed of another project that could be pursued as an alternative to continuing the original project.

Subjects were told that they were being asked to participate in an experiment on business decision making in an IT context and that their answers would remain anonymous. To minimize the possibility of demand effects, subjects were reminded that their participation was voluntary and that those who did not wish to participate were free to leave the room. Those wishing to remain were asked to complete an informed consent form before receiving the case scenario.

The previously randomized cases were distributed to the subjects in two parts. Part 1 contained the case narrative and subjective probability question shown in Appendices A and B. Subjects were asked to read the case and then decide, based on the material presented, whether to abandon or continue a software project. Sunk cost and completion were manipulated jointly at four levels (15, 40, 65, and 90%). Additionally, each of these four treatment levels were manipulated for both the "with" and "without" alternative conditions, resulting in a 2×4 factorial design (i.e., eight treatment conditions in total).

After reading the case and determining the subjective probability of continuing, subjects returned Part 1 to the administrator and were then given Part 2. In this part of the experiment, subjects were asked to provide a written explanation of the reasoning behind their decision. Subjects were instructed to "be as specific as possible regarding the factors that were most influential" in reaching a decision. Part 2 also included a manipulation check as well as several demographic questions. The qualitative data collected in this part of the experiment was later subjected to content analysis in order to determine the reasons *why* subjects chose to abandon or continue the project.

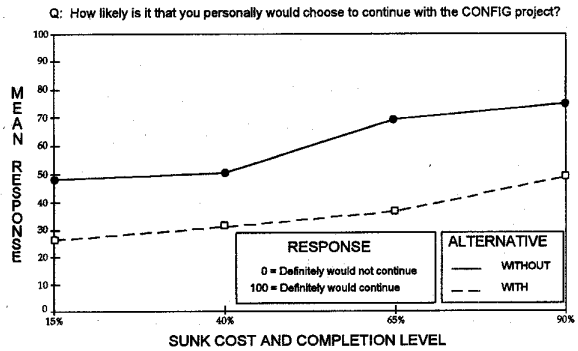


Fig. 1. MEAN probability of continuing the project by sunk cost and completion level.

As indicated in Table II, the scenarios used in this experiment differed from those used by Garland in several ways. Most of the key differences have already been discussed. One important area that has not been discussed, however, is the treatment of time.

In Garland's study, there was no attempt to control for the time required to bring a product to market. Subjects were told that the project was x% complete and that another firm had begun marketing a superior device, but they were not told how long it would take to complete the project. By varying the degree of completion without controlling for the time to completion, the Garland study may have introduced a possible confounding variable. At high levels of sunk cost and completion, subjects may have been more willing to continue the project simply because they perceived a shorter time to completion and therefore greater economic potential. In order to control for this possibility, we decided to hold time to completion constant by explicitly stating a 6–8 month completion period across all treatment groups.

V. RESULTS

The effect of sunk cost and completion level on subjects' willingness to continue with the project is shown in Fig. 1 for both the "with" and "without" alternative groups. The upward slope of both curves is consistent with the results obtained by Garland [17].

Variable Subjective Probability of Continuing (%)
By Alternative
Sunk Cost & Completion Level (%)

Source of Variation	F	Sig of F
Main Effects		
Alternative	49.446	.000
Sunk Cost & Completion Level	10.139	.000
Interactions		
Alternative * Sunk Cost & Completion Level	.698	.554

313 cases were processed.
0 cases (.0 pct) were missing.

Fig. 2. Two way ANOVA for subjective probability of continuing.

Variable Subjective Probability of Continuing (%)
By Variable Sunk Cost and Completion Level (%)

WITHOUT Alternative

Source	F Ratio	F Prob.
Between Groups	8.021	.000

Group	Count	Mean	Standard Deviation	Mean Comparison Scheffe Test with significance level .05‡ 15%	40%	65%	90%
15%	39	48.205	31.695				
40%	39	50.513	31.867				
65%	39	69.487	28.557	*			*
90%	39	74.872	25.533	*			

Eta Squared = .137

WITH Alternative

Source	F Ratio	F Prob.
Between Groups	3.383	.020

Group	Count	Mean	Standard Deviation	Mean Comparison Scheffe Test with significance level .05‡ 15%	40%	65%	90%
15%	39	26.410	34.450				
40%	39	31.026	32.751				
65%	39	36.410	31.580				
90%	40	49.000	34.626	*			

Eta Squared = .062

‡Significant differences between means are indicated by an *.

Fig. 3. One way ANOVA for subjective probability of continuing by sunk cost and completion level.

Before conducting an analysis of main effects, a two-way factorial design ANOVA with interaction was performed to determine if there was any significant interaction effect. The results, shown in Fig. 2, indicated significant main effects, but no significant interaction effect ($p = .554$). Subsequent analysis focused on the main effects that were observed for both the sunk cost/completion manipulations ($p < .001$) and the presence or absence of an alternative course of action ($p < .001$).

A. Escalation Behavior Associated with Sunk Cost and Completion Level

One-way ANOVA's were performed to better understand the effect of sunk cost and completion level on the subjective probability of continuing with the project. Fig. 3 shows the results of the one-way ANOVA's for both the "without" alternative and the "with" alternative groups.

Both ANOVA's revealed a significant effect of either sunk cost or completion information on subjects' willingness to continue with the project. The Scheffe test with a 0.05 significance level was used as the basis for identifying significant differences that existed between groups receiving different sunk cost and completion treatments. The "without" alternative ANOVA in Fig. 3 indicates that significant differences existed in four of the six intergroup comparisons that were part of the Scheffe test. These results indicate the existence of strong sunk cost or completion effects, thus confirming the first hypothesis. The "with" alternative ANOVA in Fig. 3 indicates that significant differences existed in only one of the six intergroup comparisons; between the 15 and 90% groups. These results also lend some support for the first hypothesis, suggesting that some degree of escalation can occur even in the presence of an alternative course of action.

Variable Subjective Probability of Continuing (%)
By Variable Alternative

15% Sunk Cost and Completion Level

Source	F Ratio	F Prob.
Between Groups	8.454	.005

Group	Count	Mean	Standard Deviation	95 Pct Conf Int for Mean
Without	39	48.205	31.695	37.931 TO 58.480
With	39	26.410	34.450	5.243 TO 37.578

40% Sunk Cost and Completion Level

Source	F Ratio	F Prob.
Between Groups	7.093	.009

Group	Count	Mean	Standard Deviation	95 Pct Conf Int for Mean
Without	39	50.513	31.867	40.183 TO 60.843
With	39	31.026	32.751	20.409 TO 41.642

65% Sunk Cost and Completion Level

Source	F Ratio	F Prob.
Between Groups	23.538	.000

Group	Count	Mean	Standard Deviation	95 Pct Conf Int for Mean
Without	39	69.487	28.557	60.230 TO 78.744
With	39	36.410	31.580	26.173 TO 46.647

90% Sunk Cost and Completion Level

Source	F Ratio	F Prob.
Between Groups	14.227	.000

Group	Count	Mean	Standard Deviation	95 Pct Conf Int for Mean
Without	39	74.872	25.533	66.595 TO 83.149
With	40	49.000	34.626	37.926 TO 60.074

Fig. 4. One way ANOVA for each sunk cost and completion level by alternative.

B. Presence of Alternative and Willingness to Continue

The second major finding is that the presence of an alternative is associated with a lower willingness to continue regardless of sunk cost or completion effects. The gap between the "with" and "without" alternative plots on Fig. 1 illustrates this point. Four separate ANOVA's were performed, one for each level of sunk cost/completion, in order to test whether this difference was statistically significant. Fig. 4 shows the results of this analysis.

The results of the ANOVA's confirm that for each level of sunk cost and completion, the presence or absence of an alternative had a strong and significant effect on subjects' willingness to continue with the project. In particular, subjects' willingness to commit resources was consistently lower in the presence of an alternative course of action, thus confirming the second hypothesis.

C. Sunk Cost or Completion Effect?

Having determined that escalation occurred (particularly in the absence of an alternative course of action), we turned to content analysis to ascertain whether the escalation was due to sunk cost or the completion effect. After preparing the handwritten texts for content analysis, two of the three authors worked together to analyze each subject's response. Unique codes were created to capture the various factors that subjects indicated to be influential in their decision to abandon

	DECISION					
	CONTINUE n = 143			ABANDON n = 145		
	N = 94	freq.	%	N = 44	freq.	%
WITHOUT ALTERNATIVE n = 138	sunk cost effect	60	64	beaten by first mover	31	70
	product can be improved	33	35	product cn be improved	07	16
	market remains viable	33	35	sunk cost effect *	05	11
	completion effect	21	22			
	other company will have problems too	17	18			
	desire to recoup investment	11	12			
	N = 49	freq.	%	N = 101	freq.	%
WITH ALTERNATIVE n = 150	sunk cost effect	28	57	alternatives--available or more viable	82	81
	completion effect	12	25	beaten by first mover	73	72
	will always face competition	07	14	sunk cost effect *	10	10
	market remains viable	06	12			
	product can be improved	05	10			
	do not change hourses in mid stream	05	10			

* Subjects sometimes mentioned sunk cost as an important factor even when they chose to *abandon* the project. In this context, sunk costs were frequently used as a rationale for expressing a probability of continuing that was less than 50% but greater than zero. Only one subject mentioned that sunk cost should be ignored in deciding whether to abandon or continue the project.

Fig. 5. Most frequently mentioned factors viewed as influential in the decision to abandon or continue the project.

or continue the project. Two content variables (codes) were created at the outset; one for reasons relating to sunk cost and one for reasons relating to the completion effect. For the purposes of this analysis, the sunk cost code was applied whenever a subject referred to monetary or other resources that had already been spent. The completion code was applied whenever a subject referred to the proximity of completion or expressed a desire to continue in order to complete the project. Other codes were created as needed in order to capture other factors that subjects said they considered in reaching a decision. Using HyperRESEARCH™ software for content analysis, more than 300 usable subject responses were coded in this manner. In total, approximately 25 codes were created in order to capture a rich and subtle set of factors that were expressed as being influential in the decision.[4]

Fig. 5 shows the most frequently mentioned factors viewed as influential in the decision to abandon or continue the project. The frequency counts are presented in the form of a 2 × 2 matrix corresponding to the decision made by the subject (i.e., abandon or continue) and whether or not the subject was presented with an alternative course of action.[5] The number of subjects within each cell of the matrix is also indicated along with the percentage of subjects who mentioned a particular factor.[6]

As shown in Fig. 5, sunk cost was the most frequently mentioned factor among subjects who decided to continue the project; more than half of these subjects mentioned sunk cost as being an influential factor. The following remarks were typical:

> Too much money has already been invested to back out of the project now (t1s014, c235–305).[7]

> The company has already spent over 50% of the budget. It would be a waste of money to quit at this point (t3s096, c7–110).

As indicated in Fig. 5, sunk cost was a prominant factor even when subjects were presented with an alternative course of action that was made to appear equally or more attractive, a result that further supports the quantitative data discussed earlier. What is more, the sunk cost effect was strong enough that it was mentioned by roughly 10% of the subjects who chose to abandon the project. As the following remarks show, many of these subjects seemed to be reluctant to completely abandon the project because of sunk costs.

> "[The] large investment in CONFIG makes abandoning difficult." (t5s165, c339-391)

[4] In coding the texts, we often found that individual subjects would mention a particular factor more than once. Once a particular code was applied to that subject's text, however, we elected not to apply the same code again (within that subject's body of text) in order to avoid any possible distortion in analyzing the frequency of assigned codes.

[5] For the purpose of this analysis, a probability of continuation less than 50% was defined as abandonment and a probability of continuation greater than 50% was defined as continuation. Straddlers (i.e., subjects who chose a probability of continuation equal to 50%) were excluded from this analysis.

[6] Factors that were mentioned by fewer than 10% of the subjects in a given cell were excluded from the listings.

[7] The identifier (t1s014, c235–305) is a reference indicating that this piece of coded text was obtained from treatment group #1, subject #14, characters 235–305.

"I would keep a small staff continuing work and research on it, since so much money is tied up [in] it now." (t8s311, c384-485)

Although mentioned half as often as sunk cost, completion was also observed as an influential factor. The following remarks were typical:

"90% completion is hard to give up on." (t4s143, c321-356)

"Once you start something, finish it." (t8s312, c31-64)

It is interesting to note that among subjects in the "without alternative" treatment groups, there were two other factors that were mentioned more frequently than completion but less frequently than sunk cost. This provides further evidence of the primacy of sunk cost over completion and also suggests the need to investigate the role that other factors may play in the decision-making process.

VI. Discussion and Conclusions

This study has demonstrated that sunk cost and completion information can lead to escalation behavior within an IT project context. Both the level of sunk cost and completion, as well as the presence or absence of an alternative course of action, were shown to have an effect on subjects' willingness to continue with an IT project. As hypothesized, subjects were more willing to continue a project when the sunk cost and completion level was high. Although some escalation was still observed, subjects who were presented with an alternative course of action showed less willingness to continue with the project, as predicted.

The results of this portion of the study provide a strong replication of previous findings reported by Garland [17]. The study also provides strong empirical evidence that the presence of an alternative course of action can reduce commitment *regardless of the level of sunk cost and completion,* thus extending earlier research conducted by Northcraft and Neale [34] as well as Garland [17]. For researchers in the area of engineering management and information technology, these findings underscore the potential value in applying theories of escalation to improve our understanding of project management.

The apparent dominance of sunk cost over completion information ran counter to our hypothesis and appears to be inconsistent with the findings reported by Conlon and Garland [14]. This suggests the need to reexamine Conlon and Garland's assertion regarding the primacy of the completion effect over the sunk cost effect. There are several possible explanations for why our results differed from those obtained by Conlon and Garland. First, despite Conlon and Garland's attempt to manipulate sunk cost and completion independently, the two variables may have inadvertently remained confounded. As shown in Table III below, the manipulations used by Conlon and Garland may have had the effect of introducing additional negative information with increasing levels of sunk cost and additional positive information with increasing levels of completion. The net effect of this may have resulted in a masking of the sunk cost effect and an exaggeration of the completion effect. If true, this would explain why Conlon and Garland observed a dominance of completion over sunk cost. It does not explain, however, why these authors did not see a linearly increasing sunk cost effect in the control condition in which sunk costs were varied in the absence of any completion information (see Table I).

TABLE III
The Introduction of Inadvertent Confounding Factors

		% Completion		
		10	50	90
% Sunk cost	10	Neutral	Positive	Positive
	50	Negative	Neutral	Positive
	90	Negative	Negative	Neutral

In addition to the above explanation, there are at least two other reasons that may explain why our results appear to contradict those obtained by Conlon and Garland. One possibility is that our manipulation of sunk cost may have been stronger and more salient than our manipulation of completion. As shown in the Appendices, sunk cost was mentioned once in the scenario itself and then later reinforced in the form of a table provided at the end of the scenario, whereas completion information was only given once. This may have inflated the sunk cost effect in relation to the completion effect. Another possible explanation is that by holding time to completion constant across all treatment groups, we may have reduced the impact of the completion effect. Further study is therefore needed in order to draw firm conclusions about the relative contribution of sunk cost and completion information.

VII. Directions for Future Research

Researchers wishing to extend this work should be aware of several limitations associated with the approach taken here. First, the results reported here are based on a single laboratory experiment and one must be cautious in generalizing from them. While role-playing experiments in which subjects are asked to decide whether or not to continue funding an IT project can be an effective means of generating new understanding of the factors that can lead to project escalation, the issue of external validity should be further investigated. Laboratory studies such as the one described here should be conducted with practicing managers. In addition, more field-based research is needed to determine the extent to which sunk cost effects are associated with actual cases of runaway IT projects. To date, only a handful of field-based studies involving escalation have been conducted [37], [38].

Despite these limitations, the findings reported here may have important ramifications for engineering project managers in general and for IT project managers in particular. While additional research is needed, the results suggest that managers should be made aware of both sunk cost and completion effects to avoid making escalating commitments to a failing course of action. The results also suggest that managers can be made less susceptible to escalation if they are trained to consider alternative courses of action. Project management techniques that force decision makers to generate alternatives may be one effective means of reducing escalation.

Further work is needed to determine the relative contribution of sunk cost and completion information and to investigate whether IT projects are any more prone to escalation than

other types of projects. The software project management literature suggests that these projects are notoriously difficult to control [2], [13], [15], [46] for at least two reasons. First, the intangible nature of software [1] makes it difficult to determine project status and to obtain accurate estimates regarding time to completion. This difficulty manifests itself in the "90% syndrome" which may actually promote escalation by reinforcing a perception that successful completion is nearly at hand.[8] Second, the volatility of requirements that is characteristic of software projects [1], [46] invites a kind of creeping escalation of project scope. Almost certainly, projects that are subject to such volatility are more difficult to control. Based on this logic, one might expect IT projects to be particularly prone to escalation. Future research should be conducted to determine if this can be shown empirically.

APPENDIX A

15% SUNK COST CASE WITHOUT ALTERNATIVE[9,10]

A. CompuSys Corporation

You are the president of CompuSys Corporation, a small computer software startup company. Your company has been working on a promising and potentially lucrative research project aimed at developing a software product for external sale. Your company's entire development effort is aimed at producing a software product called CONFIG that will appeal to the major computer companies in the US, all of which are known to be experiencing significant costs due to configuration errors made by their sales representatives. The configuration task performed by sales representatives requires putting together, or configuring, a group of components that are compatible with one another and that, when combined, will result in a complete and functioning system for the customer. The CONFIG project involves the development of an artificial intelligence system capable of aiding sales representatives with the complex task of customizing a computer system to meet a customer's specific needs.

You have already spent $1.5 million of the $10 million budgeted for the CONFIG project. The development of the CONFIG project is 15% complete and will require an estimated six to eight months for completion. Another firm has just started marketing a software package designed to solve the same type of configuration problems, and it is reported to have much more functionality than CONFIG and greater ease-of-use. Now, you are faced with the decision of whether or not to continue with the CONFIG project. (See table at top of page.)

Amount spent to date	Amount required to complete	Total development budget	Time required to complete development
$1.5 million	$8.5 million	$10.0 million	6-8 months

B. Case Questionnaire

Instructions: Please answer the following question based on the case you have just read. In answering the question please *assume that you are the President of CompuSys Corporation.*

Given the choice of whether or not to continue, how likely is it that you personally would choose to continue with the CONFIG project? (Please circle the number that best represents your decision.)

Definitely would **not** continue									Definitely **would** continue	
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

APPENDIX B

15% SUNK COST CASE WITH ALTERNATIVE

A. CompuSys Corporation

You are the President of CompuSys Corporation, a small computer software startup company. Your company has been working on a promising and potentially lucrative research project aimed at developing a software product for external sale. Your company's entire development effort is aimed at producing a software product called CONFIG that will appeal to the major computer companies in the US, all of which are known to be experiencing significant costs due to configuration errors made by their sales representatives. The configuration task performed by sales representatives requires putting together, or configuring, a group of components that are compatible with one another and that, when combined, will result in a complete and functioning system for the customer. The CONFIG project involves the development of an artificial intelligence system capable of aiding sales representatives with the complex task of customizing a computer system to meet a customer's specific needs.

You have already spent $1.5 million of the $10 million budgeted for the CONFIG project. The development of the CONFIG project is 15% complete and will require an estimated six to eight months for completion. Another firm has just started marketing a software package designed to solve the same type of configuration problems, and it is reported to have much more functionality than CONFIG and greater ease-of-use.

Recently, your market researchers have also determined that there is another project that your company could pursue that would have a profit potential equal to that which was originally forecasted for CONFIG. This other project—called COMPULERT—involves the development of an artificial intelligence system for monitoring, diagnosing, and reporting computer hardware problems before they become serious. This

[8] The 90% syndrome refers to the tendency for estimates of work completed on a software project to increase steadily until a plateau of 90% is reached. The problem, according to Brooks [13] is that software projects tend to be "90% complete" for half of the total coding time.

[9] This case, as well as the "with alternative" version shown as Appendix B, was modified to reflect the four levels of sunk costs that were manipulated (15, 40, 65, and 90%). **Total development budget** was held constant at $10 million in each scenario and **Time required to complete development** was held constant at six to eight months. **Amount spent to date and Amount required to complete** were adjusted to reflect the sunk cost level of the scenario.

[10] The use of the product name CONFIG for this research was purely arbitrary. No relationship to any real product or system is intended or implied.

Decision Choice	Amount spent to date	Amount required to complete	Time required to complete development
Continue with CONFIG	$1.5 million	$8.5 million	6-8 months
Reallocate resources to COMPULERT	$0.0 million	$8.5 million	6-8 months

development effort would be aimed at producing a software product that would appeal to the major computer companies in the US, all of which are under increasing pressure to improve the level of service provided to their customers. A technical assessment of the project indicates that COMPULERT will require six to eight months to develop and will cost $8.5 million. Now, you are faced with the decision of whether to continue with the CONFIG project or to reallocate the remaining funds toward the development of the COMPULERT project (see the table at top of the page).

B. Case Questionnaire

Instructions: Please answer the following question based on the case you have just read. In answering the question please *assume that you are the President of CompuSys Corporation.*

Given the choice of whether to continue with CONFIG or to reallocate resources to COMPULERT, how likely is it that you personally would choose to continue with the CONFIG project? (Please circle the number that best represents your decision.)

Definitely would **not** continue 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% Definitely **would** continue

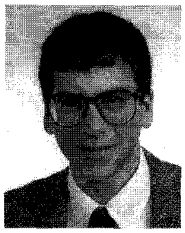
ACKNOWLEDGMENT

The authors wish to thank Merwyn Elliott, Detmar Straub, and Gabriel Ramirez for their comments on earlier drafts of this paper, and Kuldeep Kumar for his help in testing a preliminary version of the cases. Special thanks to Nicole Jungee Nie for her help in preparing text for content analysis.

REFERENCES

[1] T. Abdel-Hamid and S. E. Madnick, *Software Project Dynamics: An Integrated Approach.* Englewood Cliffs, NJ: Prentice Hall, 1991.
[2] T. K. Abdel-Hamid, "Understanding the '90% syndrome' in software project management: A simulation-based case study," *J. Syst. and Software,* vol. 8, no. 4, pp. 319–330, 1988.
[3] ——, "Investigating the cost/schedule trade-off in software development," *IEEE Software,* pp. 97–105, Jan. 1990.
[4] T. K. Abdel-Hamid and S. E. Madnick, "Lessons learned from modeling the dynamics of software development," *CACM,* vol. 32, no. 12, pp. 1426–1438, 1989.
[5] S. Alter, *Decision Support Systems.* Reading, MA: Addison-Wesley, 1980.
[6] S. Alter and M. Ginzberg, "Managing uncertainty in MIS implementation," *Sloan Manage. Rev.,* vol. 20, no. 1, pp. 23–31, 1978.
[7] H. R. Arkes and C. Blumer, "The psychology of sunk cost," *Organizational Behavior and Human Decision Processes,* vol. 35, pp. 124–140, 1985.
[8] R. H. Ashton and S. S. Kramer, "Students as surrogates in behavioral accounting research: Some evidence," *J. Account. Res.,* vol. 18, no. 1, pp. 1–15, 1980.
[9] M. Betts, "Feds debate handling of failing IS projects," *Computerworld,* Nov. 2, 1992, p. 103.
[10] B. W. Boehm, *Software Engineering Economics.* Englewood Cliffs, NJ: Prentice-Hall, 1981.
[11] C. P. Bonini, "Capital investment under uncertainty with abandonment options," *J. Finan. and Quantitative Analysis,* vol. 12, no. 1, pp. 39–54, 1977.
[12] J. Brockner, "The escalation of commitment to a failing course of action: Toward theoretical progress," *Acad. Manage. Rev.,* vol. 17, no. 1, pp. 39–61, 1992.
[13] F. P. Brooks, *The Mythical Man-Month: Essays on Software Engineering.* Reading, MA: Addison-Wesley, 1975.
[14] D. E. Conlon and H. Garland, "The role of project completion information in resource allocation decisions," *Acad. Manage. J.,* vol. 36, no. 2, pp. 402–413, 1993.
[15] T. DeMarco, *Controlling Software Projects.* New York: Yourdon, 1982.
[16] E. A. Dyl and H. W. Long, "Abandonment value and capital budgeting: Comment," *J. Finance,* vol. 24, no. 1, pp. 88–95, 1969.
[17] H. Garland, "Throwing good money after bad: The effect of sunk costs on the decision to escalate commitment to an ongoing project," *J. Appl. Psych.,* vol. 75, no. 6, pp. 728–731, 1990.
[18] H. Garland and S. Newport, "Effects of absolute and relative sunk costs on the decision to persist with a course of action," *Organizational Behavior and Human Decision Processes,* vol. 48, pp. 55–69, 1991.
[19] H. Garland, C. A. Sandefur, and A. C. Rogers, "De-escalation of commitment in oil exploration: When sunk costs and negative feedback coincide," *J. Appl. Psych.,* vol. 75, no. 6, pp. 721–727, 1990.
[20] J. E. Gaumnitz and D. R. Emery, "Asset growth, abandonment value and the replacement decision of like-for-like capital assets," *J. Finan. and Quantitative Anal.,* vol. 15, no. 2, pp. 407–419, 1980.
[21] M. J. Ginzberg, "Early diagnosis of MIS implementation failure: Promising results and unanswered questions," *Manage. Sci.,* vol. 27, no. 4, pp. 459–478, 1981.
[22] M. E. Gordon, L. A. Slade, and N. Schmitt, "The 'Science of the Sophomore' revisited: From conjecture to empiricism," *Acad. Manage. Rev.,* vol. 11, no. 1, pp. 191–207, 1986.
[23] K. M. Howe and G. M. McCabe, "On optimal asset abandonment and replacement," *J. Finan. and Quantitative Anal.,* vol. 18, no. 3, pp. 295–305, 1983.
[24] C. T. Hughes and M. L. Gibson, "Students as surrogates for managers in a decision-making environment: An experimental study," *J. Manage. Inform. Syst.,* vol. 8, no. 2, pp. 153–166, 1991.
[25] D. Kahneman and A. Tversky, "Prospect theory: An analysis of decisions under risk," *Econometrica,* vol. 47, pp. 263–291, 1979.
[26] D. Kahneman and A. Tversky, "Choices, values, and frames," *Amer. Psychologist,* vol. 39, pp. 341–350, 1984.
[27] S. P. Keider, "Why systems development projects fail," *J. Inform. Syst. Manage.,* vol. 1, no. 3, pp. 33–38, 1984.
[28] M. Keil, "Pulling the plug: Software project management and the problem of project escalation," *MIS Quart.,* in press.
[29] M. Keil, R. Mixon, T. Saarinen, and V. Tuunainen, "Understanding runaway information technology projects: Results from an international research program based on escalation theory," *J. Manage. Inform. Syst.,* vol. 11, no. 3, pp. 67–87, 1995.
[30] C. F. Kemerer, "An empirical validation of software cost estimation models," *CACM,* vol. 30, no. 5, pp. 416–429, 1987.
[31] S. Kindel, "The computer that ate the company," *Finan. World,* vol. 161, no. 7, pp. 96–98, Mar. 31, 1992.
[32] F. W. McFarlan, "Portfolio approach to information systems," *Harvard Bus. Rev.,* vol. 59, no. 5, pp. 142–150, 1981.
[33] F. W. McFarlan and J. L. McKenney, *Corporate Information Systems Management: The Issues Facing Senior Executives.* Homewood, IL: Irwin, 1983.
[34] G. B. Northcraft and M. A. Neale, "Opportunity costs and the framing of resource allocation decisions," *Organizational Behavior and Human Decision Processes,* vol. 37, no. 3, pp. 348–356, 1986.
[35] A. A. Robichek and J. C. Van Horne, "Abandonment value and capital budgeting," *J. Finance,* vol. 22, pp. 577–589, 1967.
[36] ——, "Abandonment value and capital budgeting: Reply," *J. Finance,* vol. 24, no. 1, pp. 96–97, 1969.
[37] J. Ross and B. M. Staw, "Expo86: An escalation prototype," *Admin. Sci. Quart.,* vol. 31, pp. 274–297, 1986.
[38] ——, "Organizational escalation and exit: Lessons from the Shoreham nuclear power plant," *Acad. Manage. J.,* vol. 36, no. 4, pp. 701–732, 1993.
[39] J. Rothfeder, "It's late, costly, incompetent—But try firing a computer system," *Business Week,* pp. 164–165, Nov. 7, 1988.
[40] R. Sabherwal, M. K. Sein, and G. Marakas, *Why Do Organizations*

Increase Commitment to Failing Information Systems Projects?, working paper, Florida Int. Univ., Nov. 1994.
[41] D. P. Slevin and J. K. Pinto, "The project implementation profile: New tool for project managers," *Proj. Manage. J.,* vol. 17, no. 4, pp. 57–70, 1986.
[42] B. M. Staw and J. Ross, "Behavior in escalation situations: Antecedents, prototypes, and solutions," in *Research in Organizational Behavior,* B. M. Staw and L. L. Cummings, Eds. Greenwich, CT: JAI, 1987, vol. 9, pp. 39–78.
[43] ——, "Understanding behavior in escalation situations," *Sci.,* vol. 246, pp. 216–220, 1989.
[44] A. I. Teger, *Too Much Invested to Quit,* Pergamon Gen. Psychol. Series. New York: Pergamon, 1980.
[45] A. Tversky and D. Kahneman, "The framing of decisions and the psychology of choice," *Sci.,* vol. 211, pp. 453–458, 1981.
[46] R. W. Zmud, "Management of large software efforts," *MIS Quart.,* vol. 4, no. 2, pp. 45–55, 1980.



Mark Keil received the B.S.E. degree in chemical engineering from Princeton University, the S.M. degree in management from the Massachusetts Institute of Technology, and the D.B.A. degree in management information systems from Harvard Business School.

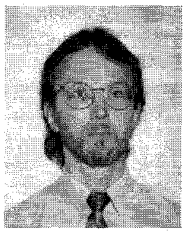
He is presently an Assistant Professor of Computer Information Systems in the College of Business Administration at Georgia State University. His industry experience includes work as a process development engineer for Du Pont and as an information systems developer and consultant. His current research focuses on software project management and his articles on this topic have appeared in SLOAN MANAGEMENT REVIEW, COMMUNICATIONS OF THE ACM, JOURNAL OF MANAGEMENT INFORMATION SYSTEMS, and DECISION SUPPORT SYSTEMS.

Dr. Keil is a member of the Association for Information Systems (AIS), The Academy of Management, and the Insititute for Operations Research and the Management Sciences (INFORMS).

Duane P. Truex III received the M.B.A. and Ph.D. degrees in information systems from The State University of New York at Binghamton.

At present he is an Assistant Professor of Computer Information Systems in the College of Business Administration at Georgia State University. His work experience includes 14 years as a chief executive of various arts councils, symphony orchestras, and museums. His current research interests focus on the interaction of organizational change and organizational culture on the information systems development process. He has published in various proceedings and *IFIP Transactions.*

Dr. Truex is a member of the International Federation of Information Processing Working Group on The Interaction of Information Systems and the Organization (IFIP WG 8.2) and the Association of Computing Machinery.



Richard Mixon received the B.S. degree from the University of Georgia and the M.S. degree in computer information systems from Georgia State University.

His work experience includes many years as a systems analyst and a project manager, during which he worked primarily on large financial systems. His current research interests are systems planning and project management. His work has been published in the *Journal of Management Information Systems* and various conference proceedings, including the *International Conference on Information Systems.*