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Control and Team Self-control on Innovation Speed:
The Moderating Effect of Product Newness

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The direct and combined effects of managerial output control and team self-control on innovation speed: the moderating effect of product newness

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Abstract

This study examines how control mechanisms used in new product development (i.e. output control and team self-control) influence innovation speed. By studying 245 new product projects, we found that output control is positively related to innovation speed. The use of team self-control had no significant effect on innovation speed. However, a positive interaction effect was found between output control and team self-control on innovation speed. Output control appeared to be more positively related to innovation speed for incremental innovations than for radical ones.

Keywords: innovation speed, output control, team self-control, product newness

1. Introduction

Innovation speed is emerging as a pivotal factor for strategic success in an expanding variety of industries. Firms today face highly competitive and dynamic environments and the associated need to bring products to market more quickly (Pearce 2002). In studying the determinants of speed, Menon & Lukas (2004) highlight one variable as crucial: control. While control mechanisms have been studied in other contexts (e.g. information systems design teams, store salespersons, marketing personnel, R&D scientists); these mechanisms have received very little attention in new product development. Greater understanding of control issues in new product development is an important research priority (Bonner, Ruekert & Walker 2002; LaBahn, Ali & Krapfer 1996).

The purpose of this article is to advance understanding of the relationship between control mechanisms and innovation speed. Specifically, the study

has two objectives. First, it investigates both the direct and combined effects of managerial output control and team self-control on innovation speed. While some scholars have argued that managerial and team controls combine to have a positive effect on performance (Tannenbaum 1968; Feldman 1986); empirical research has tended to focus on the bivariate relationship between either form of control and performance. To date, no research has studied the interaction effect of output control and team self-control on innovation speed.

Second, the study explores the moderating effect of product newness on the relationship between the type of control employed and the innovation speed. The innovativeness of the product being developed has been shown to determine what type of control structure is appropriate. Jaworski, Stathakopoulos & Krishnan (1993) stated that when tasks are routinized and predictable, hierarchical control is effective because coordination and control by plan and schedule is possible; when tasks become variable and work sequencing is difficult to predict, decentralized control is more effective. The next section introduces the hypotheses. This is followed by a description of the methodology used for the empirical test of the hypotheses. Finally the results are reported followed by a discussion of the results.

2. Hypotheses

Organizational control is defined as “the mechanisms through which an organization can be managed so that it moves toward its objectives” (Ouchi 1979). One form of control that has received attention in the new product development literature is output control. Output control is defined as the degree to which the managers sets, monitors and evaluates the outcome produced by the team (Henderson & Lee 1992). Firm’s relying on output control manage the development teams by establishing broad objectives (e.g. launch date, cost constraints, performance goals) and monitoring the

achievement of the goals. A second form of control is team self-control. Team self-control occurs when NPD team members exercise control over how they accomplish their tasks. Mechanisms supporting team self-control may include the team identifying and establishing standards for its own behavior, or establishing a timetable for project milestones and monitoring progress against these milestones (Choudhury & Sabherwal 2003). This concept is similar to what other authors have termed *team operational control influence* (Bonner et al. 2002), *team autonomy* (Takeuchi & Nonaka 1984; Sethi 2000) and *process adaptability* (Tatikonda & Montoya-Weiss 2001). Innovation speed is defined as the pace of progress that a firm displays in innovating and commercializing new products. It describes a firm's capability to accelerate the activities and tasks that occur through the new product development process (Chen, Reilly & Lynn 2005; Kessler & Bierly 2002; Kessler & Chakrabarti 1999).

2.1. The direct effect of output control on innovation speed

Managerial output control is exercised to the extent that management sets performance standards and monitors results. Output control is likely to have a positive impact on innovation speed. Literature in new product development suggests that goal setting and frequent milestones tend to increase task motivation and create a sense of order within the project teams, thereby speeding up new product development (Kessler & Chakrabarti, 1996). Milestones serve as key target that infuse team members with a sense of urgency and keep them focused on time-based objectives (Gersick, 1988). Despite its perceived importance, empirical findings report a lack of relationship between output control and time-to-market (Henderson & Lee 1992; LaBahn et al. 1996). These results encourage future research into the effect of output control on innovation speed. In this study we propose:

H1: Output control is positively related to innovation speed.

2.2. The direct effect of team self-control on innovation speed

Literature suggests development teams that have the authority and capability to make their own decisions, achieve faster results. For one thing, decentralizing decision making reduces frequent, mandated changes in the product (Emmanuelides 1993) and limits the number of bureaucratic approvals. Without significant control over the development program, team members will likely blame external causes to the product's failure rather than attribute failure to their own shortcomings (Kelly 1972). Empowerment of the development team can motivate individuals by giving them a sense of control over the project's outcomes (Zirger & Hartley 1994). Henderson & Lee (1992) found that team's self-control was positively correlated with the team's ability to meet the project's goals. Tatikonda & Montoya-Weiss (2001) revealed a positive relationship between the degree of discretion available to project managers regarding work activities and decisions, and time-to-market. Bonner et al. (2002) found that team's participation in setting operational control mechanisms – such schedule, budget, rules and procedures, was associated with superior project performance. Drawing on this evidence, we propose that:

H2: Team-member self-control is positively related to innovation speed.

2.3. The interaction effect of output control and team self-control on innovation speed

We propose that managerial output control and team self-control combine to have a positive effect on innovation speed. We justify this analysis on

Tannenbaum (1968)'s argument that a high degree of control by the managers is necessary for the efficient administration of an organization and, at the same time, a high degree of team-member control is also necessary to foster identification, motivation, and loyalty. Similarly, Feldman (1989) states that managing innovation involves the simultaneous regulation of autonomy and control in order to promote creativity and experimentation but still produce results that can be manufactured and marketed. Thus,

H3: The interaction effect of managerial output control and team-member self-control is positively related to innovation speed.

2.4. Moderating effects of product newness

The control theory predicts that output control is the most effective means of control when managers can accurately measure outputs (Jaworski 1988; Ouchi 1979). This is not as likely the case on highly innovative NPD project where there are fewer precedents on which to rely, and thus it is more difficult for management to specify realistic a priori outcomes. As noted by LaBahn et al. (1996), whereas the development of a product familiar to the market may be easily planned and implemented, the development of innovative products may have deadlines that are, at best, educated guesses. The inaccuracies introduced into the scheduling by greater product innovativeness may hamper time-efficient product development if output controls are applied rigorously. LaBahn et al. (1996) found that strong application of output control to the development of highly innovative product appears to lengthen cycle time. Thus,

H4: The more innovative a NPD project, the less positive the relationship between the degree of formal output control imposed and innovation speed.

In contrast to output control, team self-control is thought to be more positively related to innovation speed for highly innovative NPD project than for less innovativeness ones. Indeed, recent studies indicate that the use of relatively autonomous, self-directed NPD teams is positively related to faster completion times on radical projects but not on incremental ones (Kessler & Chakrabarti 1999; Olson, Walker & Ruekert, 1995). A possible reason is that relatively straightforward projects simply do not benefit substantially from the increased functional interaction and flexibility fostered by more participate structures, at least not enough to offset the higher time and human resources costs typically associated with such structures (Gupta, Raj & Wilemon 1986). Thus:

H5: The more innovative a NPD project, the more positive the relationship between the degree of team self-control and innovation speed.

3. Methodology

3.1. Sample

The frame consisted of 1,650 manufacturing firms with 50 or more employees in various industries including food, chemical, plastic, mechanical equipment, electrical equipment, and transportation. A questionnaire was mailed to the technical manager in each firm. Of the original 1650 surveys mailed, 60 were returned by the post office as undeliverable. From the remaining pool, a total of 245 completed questionnaires were received, yielding a response rate of 15%. The median respondent firm had 200 employees and 34.7 million € annual revenue.

3.2. Measures

The unit of analysis was the new product development project. Respondents were asked to base their answers on a new product project fully completed within the past 3 years. A pool of items was generated for measuring each of the constructs based on the review of the literature and interviews with academics and practitioners. The questionnaire was pretested with seven technical managers.

Two types of measures were used in this survey: formative multi-item measures and reflective multi-item measures. If a construct was a summary index of observed variables, we used a formative measurement model. In this case, observed variables cover different facets of the construct and cannot be expected to have significant inter-correlations (Diamantopoulos & Winklhofer 2001). Based on our understanding and conceptualization of the team self-control and product newness variables, it appears appropriate to use formative measurement approaches for these constructs. In contrast, if observed variables were manifestations of underlying constructs, we used a reflective measurement model (Diamantopoulos & Winklhofer 2001). The reflective multi-item measures used were innovation speed, output control, team stability, team experience and NPD resources¹. The operational definition, and scales items for each construct are provided in Appendix.

Validation of the reflective variables began by assessing construct reliability². As shown in appendix, the Cronbach's alpha values were greater than .70, which indicates good reliability. Internal consistency and convergent validity were investigated by performing a confirmatory factor analysis using AMOS. The results indicated that the measurement model fit the data well ($\chi^2=225.46$, $DF=109$, $p<0.00$; Normed Fit Index (NFI) = 0.98; Comparative Fit Index (CFI) = 0.99; Root Mean Square Error of Approximation (RMSEA) = 0.07). Values for composite reliability and

¹ Firm's NPD resources, team stability and team experience were included in the study as control variables.

² For formative variables, traditional measures of internal consistency and validity assessment are inappropriate and illogical (Diamantopoulos & Winklhofer 2001; Jarvis, Mackenzie, & Podsakoff 2003).

average variance extracted exceeded the standards of 0.7 and 0.5 suggested by Bagozzi & Yi (1988). Together the results of the tests suggest that the reflective measures included in this study possess sufficient unidimensionality, reliability and validity. For hypotheses testing analysis, we developed summated composites. Table 1 shows the zero-order correlations along with means and standard deviations.

Table 1. Means, Standard Deviations and Zero-order Correlations

	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.
1. Innovation speed	3.9	1.2	1.00						
2. Output control	5.2	1.2	.32**	1.00					
3. Team self-control	4.9	1.4	.07	.05	1.00				
4. Product newness	4.7	1.2	.17**	.14*	.07	1.00			
5. Team experience	5.2	1.2	.23**	.35**	.03	-.04	1.00		
6. NPD resources	5.5	0.9	.29**	.38**	.07	.08	.36**	1.00	
7. Team stability	6.2	1.1	.24**	.17**	.04	.17**	.16*	.15*	1.00

Significance levels: ** p<.01, * p<.05; + p<.10

3. Results

Hierarchical regression analysis was used to test the hypotheses. H1 hypothesizes that output control is positively related to innovation speed, and this was found ($\beta = .21$, $p = .003$). H2 hypothesizes that team self-control has a positive effect on innovation speed. A nonsignificant regression coefficient estimate for team self-control does not support H2. H3 posit a positive interaction between output control and team self-control. The findings support H3 ($\beta = .16$, $p = .009$). The Aiken & West (1991) procedure was used to calculate coefficient estimates for team self-control at one standard deviation below and above the mean of the output control variable. At a low level of output control, a lack of relationship was found between team self-control and innovation speed, whereas at a high level of output

control, a significant positive relationship was found between team self-control and innovation speed ($\beta = .27$ $p = .057$).

As predicted in H4, the interaction effect between output control and product newness was negative and significant ($\beta = -.16$ $p = .009$) in explaining innovation speed. The Aiken & West (1991) procedure revealed a significant positive relationship between output control and innovation speed at a low level of product newness ($\beta = .29$ $p = .081$). At a high level of product newness the relationship between output control and innovation speed was not significant. Results fail to support H5, which predicted that the higher the product newness, the more positive the relationship between team self-control and innovation speed. As shown in Table 2, the interaction term between team self-control and product newness was not significant.

Table 2. Hierarchical regression analysis: Standardized coefficients

	Dependent variable: Innovation		
	Model 1	Model 2	Model 3
<i>Control variables</i>			
Team experience	.04	.04	.04
NPD resources	.17*	.17*	.18**
Team stability	.20**	.20**	.20**
<i>Control mechanisms</i>			
Output control	.25**	.24**	.21**
Team self-control	.04	.04	.04
Output control*Team self-		.14*	.16**
Output control*Product			-.16**
Team self-control*Product			.00
R ² (F-value)	.21	.23	.26 (8.84)

Significance levels: ** $p < .01$, * $p < .05$; + $p < .10$

5. Discussion

For many companies, innovation speed is a central component of their competitive strategy. This study contributes to our understanding of how

organizational control mechanisms contribute to innovation speed. Our evidence shows that greater output control increases innovation speed. However, managers must consider the circumstances surrounding the development product before instituting project controls. For example, stronger application of output control to the development of highly innovative products does not appear to increase innovation speed.

The study found evidence that the use of team self-control has no significant effect on innovation speed. However, a positive interaction effect was found between managerial output control and team self-control on innovation speed. This result is consistent with Feldman (1989)'s argument that team autonomy without the corresponding use of managerial control, makes it difficult to speed up innovation. Autonomous employees acting independently of managerial control have a tendency toward miscommunication with regard to the requirements they are supposed to meet, and can easily develop attitudes or goals incompatible with the development's goals. In a similar vein, Bonner et al. (2002) note that autonomous NPD teams are free to wander off-strategy, pursue design options that exceed the firm's competencies resources, engage in endless partisan debate and run behind schedule or over budget before drawing the attention of higher-level management. Managerial output control can help keep new product teams on an appropriate strategic track and to avoid unwelcome surprises. Finally, the results indicate that product newness does not moderate the relationship between team self-control and innovation speed. This result is consistent with Tatikonda & Montoya-Weiss (2001)'s work, but it runs counter to our expectations.

As stated by LaBahn et al. (1996) new product development is an important organizational process that must be monitored and controlled in some way. This study has offered new insights into the difficult decision of how much and what type of control to impose on teams in order to speed up

the NPD process. By doing so, the study provides a useful foundation for further research on the effects of organizational control mechanisms on innovation speed.

Appendix. Construct definition and measures

Construct name	Construct measurement	Mean (S.D.)
Innovation speed ¹ (Cooper & Kleinschmidt 1994, Akgün & Lynn 2002; Kessler & Bierly 2002) (α =.76, CR=.78, AVE=.55)	The project was completed in less time than what was considered normal and customary for our industry	4.12 (1.42)
	The project was launched on or ahead of schedule	4.07 (1.31)
	The project was done fast relative to how it could have been done	3.55 (1.71)
Output control ¹ (LaBahn et al. 1996; Bonner et al. 2002) (α =.84, CR=.85,	There were formal goals set for this project	5.39 (1.43)
	Project's performance was monitored	5.38 (1.55)
	There were cost control mechanisms for the project	4.97
	There were quality control mechanisms for the project	4.97
Team self-control ^{2 a} (Bailyn 1985; Sethi 2000)	There were schedule control mechanisms for the	5.12 (1.83)
	Determined rules and procedures	4.52 (1.85)
	Decision-making on project issues	5.01 (1.79)
	Determined scheduling of activities	5.01 (1.79)
Product newness ^{3 a}	Amount of change involved in the project relative to:	
	1) similar completed projects in the organization	4.98 (1.42)
	2) similar completed projects by competitors	4.37 (1.64)
Team experience ¹ (Emmanuelides 1993; Akgün & Lynn 2002) (α =.77, CR=.79, AVE=.56)	Experience with the technology used in the product	5.18 (1.38)
	Experience with developing similar products	5.38 (1.44)
	Experience with marketing similar products	5.17 (1.51)
Team stability ¹ (Akgün & Lynn 2002) (r =.57, CR=.72, AVE=.57)	Team members who were on the team remained on it through completion	5.92 (1.39)
	The project manager who started this project remained on through completion	6.43 (1.14)
NPD resources ¹ (Ali 2000) (α =.76, CR=.79, AVE=.50)	Our firm had the technical skills to develop the product	5.60 (1.28)
	Our firm had the marketing skills to develop the product	4.88 (1.46)
	Our firm had the managerial skills to develop the product	5.47 (1.23)
	Our firm had the financial resources to develop the product	5.84 (1.22)

¹ Seven-point Likert-type scale (1= Strongly disagree, 7 = Strongly agree)

² Seven-point scale (1= Top Management, 7= Project Team)

³ Seven-point scale (1= Very low, 7 = Very high)

^a Non applicable

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