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Practices that Support Team Learning and Their Impact on Speed to Market and New Product Success

Gary S. Lynn, Richard B. Skov, and Kate D. Abel

Competition is fierce today. Businesses are feeling extreme pressure to innovate and do so quickly. If they take too long in bringing a product to market or make a mistake along the way, they can be preempted by a faster moving competitor. One technique gaining popularity to help companies compete is establishing learning teams—teams that create and use knowledge rapidly and effectively. But how do teams learn? By studying the learning practices of 95 new product teams, we have uncovered several factors that improve a new product team's ability to learn, innovate faster, and be more successful. These factors include thoroughly reviewing project information, having stable project goals, and following a rigorous new product development process. © 1999 Elsevier Science Inc.

Introduction

Companies today are facing intense competition from both domestic as well as international organizations. If a company stumbles in its effort to compete and win, it can be preempted by a fast moving competitor. Competition, coupled with the rapid rate of technological change, has made speed to market a critical competency for successful new product development (NPD). Speed is no longer a luxury in NPD, it is an economic necessity [33]. Developing and launching a product quickly can have considerable impact on the success of the development effort. Karagozoglu and Brown [41] state that "earlier product introduction improves profitability by extending a product's sales life, creating an opportunity to charge a premium price, and allowing development and manufacturing cost advantages." McKinsey and Company argue that, under certain specific circumstances, introducing a product on budget, but 6 months late, may cut cumulative profit between 17% and 35% over 5 years. However, introducing a product with up to a 50%

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increase in budget, but on time, can cut profit by only 4% (cited in [22,65]). In light of this, it is not surprising that managers prefer to go over budget rather than delay product release [31].

Although many scholars and practitioners alike assert that speed is important to new product success, not everyone is in full agreement. Crawford [14], for example, describes five hidden costs that can be associated with accelerated product development. These include an emphasis on incremental innovation versus the more time intensive, radical innovation, increased mistakes, and increased development and commercialization costs.

Despite Crawford's reservations, we cannot ignore anecdotal evidence suggesting that speed plays an important role in successful NPD, especially in technology-intensive industries. We expect that speed to market will be critical to new product success, and therefore it is important to understand what can be done to accelerate the development process.

One technique gaining in popularity for helping to accelerate NPD is organizational learning. In this study, we will evaluate the role that organizational learning plays in reducing cycle time for successful new products. We will focus on a set of practices that NPD teams can employ to facilitate learning, speed to market, and product success.

Considering the assertions made by Gupta and Wilemon [33] and Karagozoglu and Brown [41], we expect:

> Hypothesis 1: There will be a positive correlation between speed to market and new product success.

Previous Research on Increasing Speed

McDonough and Barczak [59] noted in 1991 that "while there is keen interest in understanding how to speed up development, very little is known at present about how to do so." Recent research has moved beyond anecdotes and case studies to empirically test factors and variables that are associated with increased speed. Gupta and Wilemon [33], for example, reveal that managers perceive that the early involvement of different departmental functions and the involvement of project champions is associated with accelerated development. Other scholars have supported these beliefs [15,32,35,72]. McDonough [58] argues that project champions are an integral part of project success, and examines the impact of project manager characteristics, such as age and tenure in the current position, on speed for routine and radical tasks. For example, for routine projects, the greater the leader's number of years in the present position the slower the speed of development. Additionally, McDonough and Barczak [59] assert that when projects employed technologies developed primarily or totally within the firm, the project leader's participation was associated with increased speed. They found no effect of participation on speed when the project relied on outside technology.

These scholars and the work of others such as Cordero [12] have helped us understand some of the factors that are associated with faster cycle time. Although these and other researchers have begun to identify factors associated with speed, there is a great deal that remains to be researched. One area that is now emerging is the impact of learning, or more accurately team learning, on cycle time and new product success. Unfortunately, we know surprisingly little about the role team learning plays in NPD. As a result of this void in the literature, the present study examines the impact of team learning, and the practices that facilitate it, on speed of development and new product success.

Team Learning

There is a growing body of literature on the importance of organizational learning [3,4,18,26,36,37,39,50,55,57,61,73,74,81]. Ray Stata, Chairman of Analog Devices, has argued "that the rate at which individuals and organizations learn may become the only sustainable competitive advantage, especially in knowledge-intensive industries" [76]. The research on organizational learning borrows heavily from, and is anchored, in the field of individual cognition and learning [3,16,25,57,71]. Although the individual learning literature has helped us understand some of the complex issues surrounding organizational learning, much more work is needed on identifying specific learning practices [2,10,26,28,61,70,74,80].

Learning is important to organizations in general, but it is critical in NPD because innovation spans many functional areas including engineering, marketing, manufacturing, finance, etc., and new product teams frequently must be composed of individuals from different backgrounds and perspectives. Development is a team effort; therefore, for NPD the issue is not how do organizations learn, but rather how do new product teams learn. What practices promote team learning and do these practices increase a company's ability to innovate quickly and successfully?

Practices of Within-Team Learning

Lynn [53,54] has developed a model of organizational learning in NPD based on constructs from individual cognition and learning [19,27,38,45] and found support for the model in case studies of the development of 13 products at Apple, Hewlett-Packard, and IBM. The model includes three types of learning: Within-team Learning, Cross-team Learning, and Cross-company Learning, and he identifies several practices that support learning. In an attempt at testing the generalizability of Lynn's model, the present study will focus on Within-team Learning—how members of a new product team learn within the context of their own team. We will examine practices supportive of Within-team Learning and will explore whether the model is valid for a broader range of products in a wider cross-section of companies. Another purpose of this study is to determine if research in learning can help us to uncover important practices impacting speed and new product success.

Borrowing constructs from a number of disciplines, including cognition, team dynamics, and management strategy, the present study explores the impact of several constructs on learning, speed of product development, and new product success. These practices were selected for study based on a review of relevant research in individual learning and team performance and because they are (1) concrete actions within a firm's control and (2) practices that are likely to facilitate learning and team performance.

Recording and Reviewing

Early research on the effects of recording, called note taking in the individual learning scholarship, compared the performance of students who listened to a lecture to students who listened and took notes. Hartley [34] and Kiewra [42] reviewed 61 studies, which included this comparison, and reported that 35 studies found better learning, as measured by performance, among students who not only listened but took notes. There were 23 studies that found no significant difference, and three studies reported better performance in the condition in which no notes were taken. This research suggests that people who engage in the recording of information will learn more than those who passively listen.

A second comparison by Hartley [34] and Kiewra [42] contrasted in 32 studies the performance of students who both recorded and reviewed notes to those who recorded but were not allowed to review. Support for the facilitative effect of reviewing was found in 24 studies; the remaining 8 studies reported no significant difference between the conditions. Reviewing has been cited as being important in the organization learning literature as well. Gersick [29] asserts the importance of team meetings to group performance. These studies suggest that team members who record information will learn more if they have the opportunity to review what they have recorded individually and jointly.

Kiewra et al. [44] included a "borrowed notes" condition in which students were given a set of notes, recorded by another student, to review. They reported that students in the "borrowed notes" condition performed better than students in the record only condition (no opportunity to review) or a listen only condition. This suggests that recording not only would benefit the member engaged in the process of encoding, but other members who can later review the recorded information. Using borrowed notes has direct application to team settings where team members will frequently have to rely on notes taken by others (e.g., customer requirements documents recorded by marketing and used by engineering).

The practice of recording should facilitate team performance by increasing the knowledge of individual team members. However, for all members to benefit, the opportunity to review the recorded information must be made available to others on the team. This is demonstrated in the important link between the ability of individual team members and overall team performance. Previous research on the relationship between the abilities of team members and cumulative team performance has supported an additive model. Increasing the abilities of individual members results in better team performance [78]. This link between member ability and team performance has obvious implications for selection (select on high ability) but, more importantly in the context of the present study, strongly reinforces the beneficial effect of fostering team member learning. The performance of the group will increase when members are actively engaged in learning.

Filing

For information to be reviewed it must be accessible in a way that allows easy and fast retrieval. The importance of filing on learning and new product success has been discussed in prior scholarship [17,20,49].

Lynn et al. [56] analyzed the filing systems used in 38 companies for their new product efforts. They report that recording information, combined with an effective filing system, was positively related to a firm's overall new product success rate.

Goals

Recording, filing, and reviewing information are not the only processes that facilitate learning. Scholarship on the importance of goals to individual and group performance indicates that the practice of setting goals facilitates performance. Goals can help establish a direction so that individuals know what to record, file, and review. Having a clear goal can lead to better performance by providing a domain of interest, a focus, for effort, motivating a search for a strategy to achieve the goal. At the individual level, research has shown a robust positive effect of setting specific goals on performance—individuals with specific goals outperform those with no goals or those simply told to "do their best" [52].

The success of individual goal setting has led to the application of the principles of goal setting to teams. Larson and LaFasto [47] identify the presence of a clear (specific) goal as a characteristic of an effectively functioning team. O'Leary-Kelly et al. [67] recently reviewed research on the influence of group goals on group performance using both meta-analytic and narrative approaches. In their meta-analysis of 10 studies, the mean performance of teams that had goals was approximately 1 standard deviation (.92) above the performance of teams with no goals. (This large effect size of .92 SD for teams is even larger than the effect sizes of .52 to .82 reported in research on individual goal setting [51].) In a qualitative review of 29 studies on goal setting in teams O'Leary-Kelly et al. [67] report that 83% of the studies reported a positive effect of goal setting on performance. Not only is it important for a team to have goals, but these goals should also be specific and clear. O'Leary-Kelly et al. report that 95% of the reviewed studies found better performance when the goals were clear and specific. The above scholarship indicates a notable benefit of engaging in the practice of setting clear and precise goals.

NPD Process

While goals can provide direction to a team, a process is also needed to help in achieving the desired goal. Having a systematic NPD process can provide this framework to help new product teams achieve their goals. The importance of following a systematic NPD process has been well documented [1,10,11,23,68]. Cooper and Kleinschmidt [10], for example, found that proficiency in several NPD phases was correlated to new product success. Some of the significant phases include (1) proficiency in pre-development activities including initial screening, preliminary market and technical assessment, and completing a detailed market and business analysis; (2) proficiency in completing market activities, such as, preliminary market assessment, detailed market study, customer beta testing, and market launch; and (3) proficiency in completing technical activities, including, preliminary technical assessment, development, in-house prototype testing, and trial production [9]. Cooper and Kleinschmidt's results have been replicated by others (see for example [75]). In light of the importance of having a systematic NPD process including idea generation, screening, evaluation, development, testing, and launch, it was the final practice explored in this study.

The literature review suggests that teams can benefit when team members record information, when information is filed in a manner that allows the recorder and other members to review it at a later time, when teams have clear goals, and when a systematic NPD process is in place [63]. Based on the prior research, these practices should enable team members to learn and grow, and thus spur the entire team to higher levels of performance. Based on this arguement we hypothesize:

> Hypothesis 2: The practices of recording, filing, reviewing, setting clear goals, and having a structured NPD process will be associated with greater team learning.

Learning and Speed

Learning can have a direct impact on cycle time. Teams that learn rapidly and thoroughly should be able to innovate faster and better. Past research has indicated the positive influence that learning has on cycle time and new product success. As Meyer and Purser [62] assert, "Increasing the rate of organizational learning is the heart of a fast cycle-time strategy. To become a fast cycle-time competitor, it is essential that senior management embrace organizational learning as a strategic objective." Karagozoglu and Brown [41] found that many of the 31 high-technology com-

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panies that they studied used organizational learning to speed product development and utilized various practices to foster a climate supportive of learning. They report that benchmarking—a way to learn from other firms—was used by 35% of the companies to reduce cycle time and that building on past experience—an approach to learn from others within one's company—was used by 16% of the companies. Other researchers have recognized the importance of this link between learning and the speed-to-market [6,53,54,64]. Consistent with this scholarship, the practices associated with team learning should accelerate the speed with which new products are brought to market. Therefore, we hypothesize:

Hypothesis 3: Increases in team learning will be associated with accelerated NPD.

We also hypothesized the following:

Hypothesis 4: The practices of recording, filing, reviewing, setting clear goals and having a structured NPD process will be associated with accelerated NPD.

The literature [41,54,64] supporting Hypotheses 4 and 3 link learning, and the practices that support it, to speed of NPD. The literature [22,33,41] supporting Hypothesis 1 links increases in speed to new product success. Therefore, we would expect a relationship between learning, and the practices facilitating learning, to new product success. This leads to the following two hypotheses:

Hypothesis 5: Increases in team learning will be associated with increased new product success.

Hypothesis 6: The practices of recording, filing, reviewing, setting clear goals, and having a structured NPD process will be associated with increased new product success.

Table 1 lists each of the hypotheses along with their references. Figure 1 presents the research model with the associated hypotheses.

Questionnaire Design and Sampling Procedure

Item Development and Preliminary Reliability Analyses

To measure practices supportive of team learning, speed of development and new product success, scale items were developed based on past exploratory research [3,43,53]. Each construct was measured using multiple items and a Likert-type 0 to 10 scale (0 = strongly disagree to 10 = strongly agree). To assess the reliability of the resulting scales, we asked 49 technical managers, in a diverse cross-section of organizations, to select a completed project with which they were very familiar and to report on it. Respondents represented both consumer products companies and industrial companies. Questionnaires were returned by 28 managers, yielding a 57% response rate. Results indicated that the measures were reliable: Cronbach's alphas ranged from .63 to .93 and respondents did not have any difficulties understanding the items or scales. Accordingly, the sampling was expanded, and because no changes were made to the questionnaire or to the target population, the initial sample was included in the study sample.

In addition to the 28 respondents who participated in the reliability analyses, we sent mail surveys to 245 technical managers who were members of the American Society for Engineering Management (ASEM). We also distributed questionnaires to 47 middle-level technical managers from technology-based companies in New York and New Jersey. Again, each respondent was asked to select a completed NPD project with which they were intimately familiar. In total, 341 surveys were distributed; 95 were returned, yielding a response rate of 28%. We received a 20% response rate from the ASEM sample and a 40% response rate from the middle-level technical manager sample. The majority of respondents were senior executives or

Table 1. Hypotheses

Hypotheses	References
H1: The relationship between Speed and New Product Success	33, 41
H2: The relationship between Practices and Learning	17, 19, 20, 27, 34, 38, 42, 44, 45, 47, 49, 52–54, 56, 67
H3: The relationship between Learning and Speed	6, 44, 53, 54, 62
H4: The relationship between Practices and Speed	53, 54
H5: The relationship between Learning and New Product Success	Builds on Hypotheses 1 and 3
H6: The relationship between Practices and New Product Success	Builds on Hypotheses 1 and 4

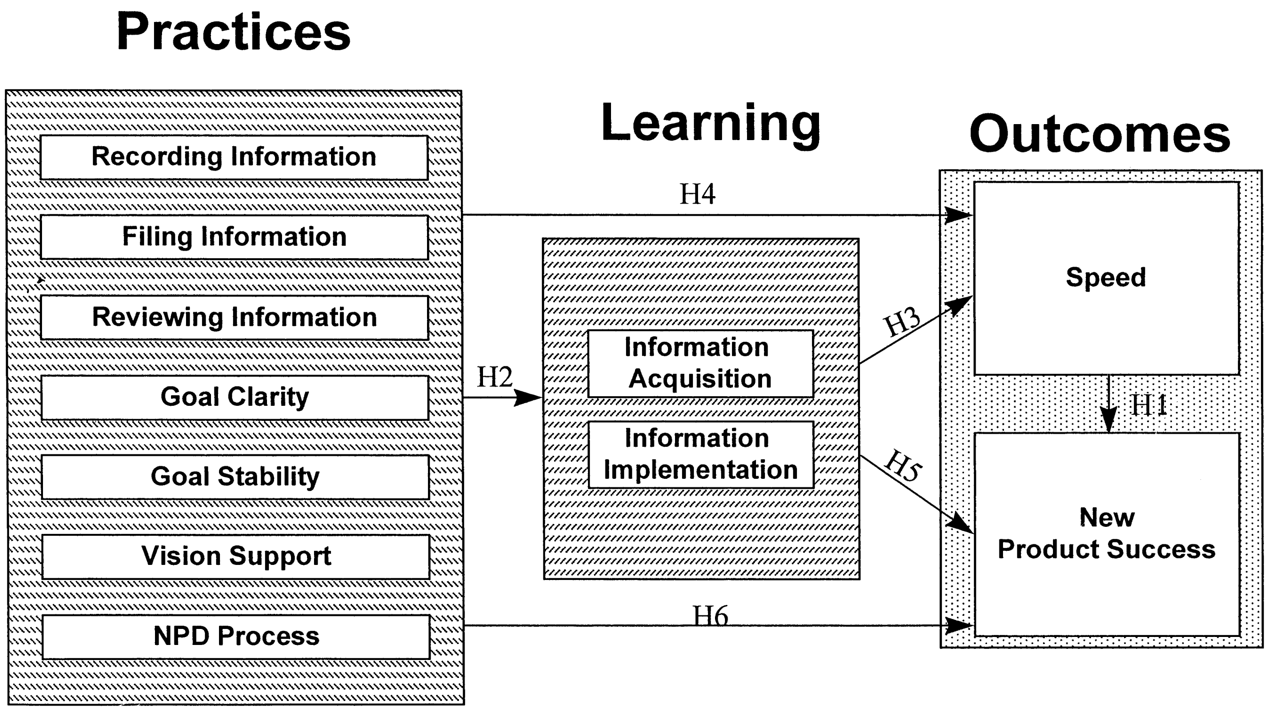

Figure 1. Within-team learning model and hypotheses.

product managers. The sample of respondents in this study was similar to samples used in other studies on innovation [24,46,59,69,77].

Because technology-intensive products are more difficult to develop and commercialize successfully [60,70] we sampled primarily from high-technology industries. In the organizations sampled, 90% were considered high technology [40,48]: 49% were in electrical and electronic machines and supplies, 16% in transportation and transportation equipment, 11% in machinery, 8% in energy, 6% in instrumentation, and the remaining 10% were in various other industries.

Factor and Reliability Analyses

Prior to testing the hypotheses the structure and reliability of each construct was assessed using factor analysis and coefficient alpha. Appendices 1A through 1D present the final scale items, rotated factor loadings and eigenvalues.

The factor analysis we completed suggested a modification of two of our constructs—Goals and Team Learning. The analysis of the goal items indicated three distinct constructs. These constructs were identified as Goal Clarity, Goal Stability, and Vision Support. These constructs are consistent with past scholarship on vision, also known as Thought Worlds [21]. The analysis of the Team Learning items identified two distinct factors: Information Acquisition and Information Implementation. Information Acquisition is the act of capturing knowledge and Information Implementation is a change in behavior based on the knowledge that has been captured. The identification of these two factors is consistent with past scholarship on organizational learning [3,37]. The three Goal constructs and the two aspects of learning were used in subsequent analyses. The resulting model driving this research is illustrated in Figure 1 and the individual items for each construct are presented in Appendicies 1A through 1D.

Consistent with preliminary analyses, all Cronbach's alphas in the complete sample were above the minimum acceptable level of .7 as recommended by Nunnally [66] and are reported in Table 2 along with the means and SDs of the scales.

Results

Analyses

Hypothesis 1 was evaluated by the zero-order correlation between Speed and New Product Success. Hypotheses 2 through 6 were each evaluated with three approaches: zero-order correlations, multiple regres-

Table 2. Characteristics of Scales

Scale	No. of Items	Mean	SD	Cronbach's α
Recording	4	5.46	.53	.76
Filing	4	5.26	.39	.81
Reviewing	4	5.16	.58	.83
Goal Clarity	6	6.29	.35	.91
Goal Stability	3	5.53	.45	.87
Vision Support	4	6.71	.79	.81
NPD Process	5	5.89	.50	.83
Information Acquisition	2	6.21	.37	.74
Information Implementation	4	6.04	.39	.77
Speed to Market	4	4.82	.65	.83
New Product Success	8	4.92	.78	.94

sion, and semi-partial correlations. Zero-order correlations are analyzed to indicate whether there is a relationship between the independent and dependent variable—ignoring the possible influence of other independent variables. Multiple regressions were used to indicate whether the set of independent variables accounted for a significant proportion of the variance in the dependent variable and are direct tests of Hypotheses 2 through 6. Semi-partial correlations were calculated to assess the importance of an independent variable in light of other independent variables. When significant, the square of the semi-partial correlation indicates the proportion of variance in the dependent variable uniquely associated with the independent variable, or alternatively, how much R^2 would decrease if the variable was dropped. Zero-order correlations are presented in Table 3 and multiple regression results and semi-partial correlations are presented in Table 4.

Hypothesis 1: The relationship between Speed and New Product Success. As predicted in Hypothesis 1, the relationship between Speed and New Product Success was significant ($r = .62$, $p < .001$). See Table 3. Increases in speed were associated with an increased likelihood of success.

Hypothesis 2: The relationship between Practices and Learning. Because the factor analysis indicated learning was comprised of two distinct constructs, Information Acquisition and Information Implementation, both forms of learning were tested.

Practices and Information Acquisition. Significant zero-order correlations with Information Acquisition were found for the practices of Reviewing ($r = .35$, $p < .01$) and NPD Process ($r = .31$, $p < .01$). See Table 3.

A standard multiple regression was performed between Information Acquisition as the dependent variable and the seven practices of Recording, Filing, Reviewing, Goal Clarity, Goal Stability, Vision Support, and NPD Process as independent variables (Table 4a). As predicted in Hypothesis 2, R for regression was significantly different from zero [$F(7,69) = 2.44$, $p < .05$]. However, only Reviewing contributed significantly to the prediction of Information Acquisition ($sr^2 = .05$). The seven independent variables in combination contributed another .15 in shared variability. All together, 20% of the variability in Information Acquisition was predicted by knowing scores on these seven independent variables.

Practices and Information Implementation. Significant zero-order correlations with Information Implementation were found for the practices of Recording ($r = .38$, $p < .001$), Filing ($r = .40$, $p < .001$), Reviewing ($r = .37$, $p < .001$), Goal Stability ($r = .30$, $p < .01$), Vision Support ($r = .24$, $p < .05$), and NPD Process ($r = .58$, $p < .001$). See Table 3.

A standard multiple regression was performed between Information Implementation as the dependent variable and the seven learning practices as independent variables. Supporting Hypothesis 2, R for regression was significantly different from zero [$F(7,72) = 6.50$, $p < .001$]. Of the variables, only NPD Process contributed significantly to the prediction of Information Implementation ($sr^2 = .10$). The seven independent variables in combination contributed another .29 in shared variability. Altogether, 39% of the variability in Information Implementation was predicted by knowing scores on these seven independent variables.

These analyses support Hypothesis 2. Learning practices do play a significant role in both forms of team learning with Reviewing uniquely contributing to Information Acquisition and NPD Process uniquely contributing to Information Implementation.

Hypothesis 3: The relationship between Learning and Speed. A significant zero-order correlation between Learning and Speed was found for Information Implementation ($r = .50$, $p < .001$). The relationship between Information Acquisition and Speed was not significant (see Table 3).

A standard multiple regression was performed between Speed as the dependent variable and Information Acquisition and Information Implementation as independent variables (see Table 4b). Supporting Hypothesis 3, R for regression was significantly different from zero [$F(2,73) = 13.73$, $p < .001$]. Information Implementation contributed significantly to the prediction of Speed ($sr^2 = .25$). The two learning variables

Table 3. Correlation Coefficients

Variables	1	2	3	4	5	6	7	8	9	10
Recording (1)										
Filing (2)	.30†									
Reviewing (3)	.40‡	.40‡								
Goal Clarity (4)	.16	.20	.43‡							
Goal Stability (5)	.19	.26*	.26*	.65*						
Vision Support (6)	.34‡	.29†	.51‡	.51‡	.46‡					
NPD Process (7)	.49‡	.53‡	.46‡	.34‡	.35‡	.41‡				
Information Acquisition (8)	.03	.21	.35†	.17	.06	.22	.31†			
Information Implementation (9)	.38‡	.40‡	.37‡	.21	.30†	.24*	.58‡	.31†		
Speed (10)	.29†	.22*	.21*	.24*	.40‡	.20	.34‡	.00	.50‡	
Success (11)	.28*	.26*	.28†	.33†	.42‡	.20	.48‡	.17	.72‡	.62‡

Significance (one-tailed test): * $p < .05$; † $p < .01$; ‡ $p < .001$.

in combination contributed another .02 in shared variability. Altogether, 27% of the variability in Speed was predicted from Information Acquisition and Information Implementation supporting Hypothesis 3.

Hypothesis 4: The relationship between Practices and Speed. Significant zero-order correlations with Speed were found for the practices of Recording ($r = .29$, $p < .01$), Filing ($r = .22$, $p < .05$), Reviewing ($r = .21$, $p < .05$), Goal Clarity ($r = .24$, $p < .05$), Goal Stability ($r = .40$, $p < .001$), and NPD Process ($r = .34$, $p < .001$). See Table 3.

A standard multiple regression was performed between Speed as the dependent variable and the seven learning practices as independent variables (see Table

Table 4a. Regression Analyses

	Hypothesis 2 (Information Acquisition)			Hypothesis 2 (Information Implementation)			Hypothesis 4 (Speed to Market)			Hypothesis 6 (New Product Success)		
Variables	Beta	*t* (df)[1]	sr^2 [2]	Beta	*t* (df)	sr^2	Beta	*t*(df)	sr^2	Beta	*t*(df)	sr^2
Recording	−.23	−1.77		.09	.86		.16	1.31		.06	.51	
Filling	.03	.19		.09	.78		.01	.06		−.02	−.16	
Reviewing	.28	1.98* (69)	.05	.15	1.22		.05	.36		.09	.66	
Goal Clarity	.03	.21		−.11	−.77		−.06	−.40		.05	.36	
Goal Stability	−.13	−.90		.19	1.48		.38	2.77† (77)	.07	.31	2.29* (72)	.05
Vision support	.07	.51		−.11	−.88		−.09	−.71		−.18	−1.38	
NPD Process	.29	1.94		.43	3.44‡ (72)	.10	.16	1.18		.37	2.77‡ (72)	.07
R^2	.20			.39			.23			.32		
F value (df)	2.44* (7,69)			6.50‡ (7,72)			3.36 (7,77)			4.86‡ (7,77)		

Significance: * $p < .05$; † $p < .01$; ‡ $p < .001$.
[1] The t-test reported is a test of Beta = 0 or alternatively $sr^2 = 0$.
[2] Sr^2 is the squared semi-partial correlation coefficient.

Table 4b. Regression Analyses

	Hypothesis 3 (Speed to Market)			Hypothesis 5 (New Product Success)		
Variables	Beta	*t*(df)	sr^2	Beta	*t*(df)	sr^2
Information Acquisition	−.17	−1.60		−.05	−.64	
Information Implementation	.55	5.24‡ (73)	.25	.73	8.52‡ (73)	.48
R^2	.27			.51		
F value (df)	13.73‡ (2,73)			38.51‡ (2,73)		

Note: sr^2 is the squared semi-partial correlation coefficient.
The *t*-test reported is a test of Beta = 0 or alternatively $sr^2 = 0$.
* $p < .05$; † $p < .01$; ‡ $p < .001$.

4a). As predicted in Hypothesis 4, R for regression was significantly different from zero [$F(7,77) = 3.36$, $p < .01$]. Goal Stability contributed significantly to the prediction of Speed ($sr^2 = .07$). The seven independent variables in combination contributed another 15% in shared variability. Altogether, 23% of the variability in Speed was predicted by knowing scores on these seven independent variables supporting Hypothesis 4.

Hypothesis 5: The relationship between Learning and New Product Success. A significant zero-order correlation with New Product Success was found for the Information Implementation ($r = .715$, $p < .001$). See Table 3.

A standard multiple regression was performed between New Product Success as the dependent variable and Information Acquisition and Information Implementation as independent variables (see Table 4b). Supporting Hypothesis 5, R for regression was significantly different from zero [$F(2,73) = 38.51$, $p < .001$]. Information Implementation contributed uniquely and significantly to the prediction of New Product Success ($sr^2 = .48$). The two independent variables in combination contributed another .03 in shared variability. Altogether, 51% of the variability in Speed was predicted by knowing scores on these two independent variables supporting Hypothesis 5.

Hypothesis 6: The relationship between Practices and New Product Success. Significant zero-order correlations with New Product Success were found for the practices of Recording ($r = .28$, $p < .05$), Filing ($r = .26$, $p < .05$), Reviewing ($r = .28$, $p < .01$), Goal Clarity ($r = .33$, $p < .01$), Goal Stability ($r = .42$, $p < .001$), and NPD Process ($r = .48$, $p < .001$). See Table 3.

A standard multiple regression was performed between New Product Success as the dependent variable and the seven learning practices as independent variables (Table 4a). Consistent with Hypothesis 6, R for regression was significantly different from zero [$F(7,72) = 4.86$, $p < .001$]. Two of the independent variables uniquely contributed to the prediction of New Product Success, Goal Stability ($sr^2 = .05$) and NPD Process ($sr^2 = .07$). The seven independent variables in combination contributed another .20 in shared variability. All together, 32% of the variability in success was predicted by knowing scores on these seven independent variables supporting Hypothesis 6.

Table 5 summarizes the hypotheses and findings.

Discussion and Conclusions

In a turbulent competitive environment, rapid NPD can help companies compete more effectively. The present study supports this assertion, which is consistent with past research [30,79]. Projects brought to market quickly were more likely to be perceived as successful. Given this link between Speed and New Product Success, identifying practices and processes that increase speed is of critical importance. The results of this research suggest that specific practices can play a significant role in accelerating the process of successful NPD.

This research complements prior scholarship that indicated the importance of several situational factors that are associated with new product success or failure [9,75]. These situational factors, such as Product Advantage, Market Synergy, Technical Synergy, and Market Potential are difficult for a firm to control. In contrast, other factors, such as the proficiency with which the new product phases are completed, are within a firm's control [9,75]. In a similar fashion, the practices we have identified here offer a firm several additional tools—we call practices—that are also within a firm's ability to control and fairly easy to implement—specifically, Reviewing, NPD Processes, and Vision.

Reviewing

Reviewing accounted for a significant and uniquely important proportion of the variance in Information Acquisition. Information Acquisition and Information Implementation accounted for a significant proportion of the variance in Speed. Information Acquisition and Information Implementation were not only related to the speed with which products were brought to market but also to new product success as well. This suggests that one approach for acquiring new information is to review knowledge captured by team members. Reviewing information encompasses conducting team meetings with engineering, marketing, and manufacturing department heads; analyzing action items from team-staff meetings; reviewing technical quality prototype test reports; and reviewing customer reaction reports to product concepts. Anecdotal evidence from past exploratory research that the authors have recently conducted demonstrates how reviewing can take place in practice on a new product team. When the Apple II team at Apple Computer developed its highly successful Apple II personal computer, team

Table 5. Summary of Results

Hypothesis	Supported or Not Supported
H1: The Relationship between Speed and New Product Success	*Supported*
Speed → New Product Success	*Supported*
H2: The Relationship between Practices and Learning	*Supported*
Recording → Information Acquisition	
Filing → Information Acquisition	
Reviewing → Information Acquisition	*Supported*
Goal clarity → Information Acquisition	
Goal Stability → Information Acquisition	
Vision Support → Information Acquisition	
NPD Process → Information Acquisition	
Recording → Information Implementation	
Filing → Information Implementation	
Reviewing → Information Implementation	
Goal clarity → Information Implementation	
Goal Stability → Information Implementation	
Vision Support → Information Implementation	
NPD Process → Information Implementation	*Supported*
H3: The Relationship between Learning and Speed	*Supported*
Information Acquisition → Speed	
Information Implementation → Speed	*Supported*
H4: The Relationship between Practices and Speed	*Supported*
Recording → Speed	
Filing → Speed	
Reviewing → Speed	
Goal clarity → Speed	
Goal Stability → Speed	*Supported*
NPD Process → Speed	
H5: The Relationship between Learning and New Product Success	*Supported*
Information Acquisition → New Product Success	
Information Implementation → New Product Success	*Supported*
H6: The Relationship between Practices and New Product Success	*Supported*
Recording → New Product Success	
Filing → New Product Success	
Reviewing → New Product Success	
Goal clarity → New Product Success	
Goal Stability → New Product Success	*Supported*
Vision Support → New Product Success	
NPD Process → New Product Success	*Supported*

reviewing occurred throughout every phase of development and commercialization. The main reason was because the Apple II team was located in one room—a garage—and, as a result, there were “review meetings,” held throughout the day, allowing constant sharing of information among team members. In our interviews, Chris Espinosa, who was one of Apple’s earliest employees and who worked on the II, describes the situation:

> During most of the development of the Apple II, Apple did not have formal offices. The company was literally operating out of a garage. The only working place was this one room in the garage. Any decisions or discussions that needed to take place were decided or discussed there with basically everybody present.

NPD Process

The NPD Process accounted for a significant and unique portion of the variance in Information Implementation. For teams to implement the information they have acquired an appropriate process is necessary. The NPD process may be able to provide a team with the framework to translate information into ac-

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tion. The NPD process embodies following a clear plan—a roadmap with measurable milestones, having mechanisms to track the project's progress and costs according to the plan; and proficiently completing the process in a logical sequence including (1) idea generation, (2) screening and evaluation, (3) development, (4) testing, and (5) launch.

Although there is evidence supporting the importance of a rigorous, systematic NPD process caution must be exercised to avoid over-reliance on a rigid process. Having too rigid of an NPD process can be counterproductive because core competencies, that become manifest in a structured well-articulated and well-defined process, can become core rigidities and detract from successful NPD [49]. As an example, when IBM developed its famous PC, the company had developed a very structured NPD process—one that had been refined over many years. Had the PC team followed IBM's well-established, rigorous process, the team would not have been able to develop and launch its product in the record 13-month time frame that it did.

IBM's traditional NPD process up to that time required, on average, 3 to 6 years for a product to be developed and commercialized because of all the gates and reviews a product had to pass through. The PC team was able to reach market in record time because it was allowed to skip some phases and circumvent IBM's traditional process. From an interview we conducted with Bill Lowe, the initial PC project manager, the temptation to blindly follow a company's NPD process must be tempered because it can actually impede learning. As Lowe describes:

> We looked at the IBM development process and said, "Let's understand what it's intended to do, rather than what it requires you to do. Let's put together a process that will meet the requirements that it's trying to enforce rather than taking all the procedural steps it requires."

As a result, the IBM PC team instituted a "new" NPD process that streamlined how a product proceeded from concept to market.

In light of the IBM PC story, several key questions pertaining to the NPD Process remain. When should a company's well-accepted NPD process be permitted to be circumvented? And its inverse: when should new product teams be forced to use the tried-and-true process that the company has spent years refining? When does the NPD Process help and when does it hinder new product success? Although we would like to answer these questions, the correct response is not obvious and more research is necessary. One approach is to do what Lowe and his team did with the PC. They tried to understand the objectives of the process and the project and then reconcile both goals together. When dealing with technological innovation, new product teams may need to continually critically evaluate the firm's NPD process to determine if it is appropriate or if it needs to be modified.

Vision

"Vision" has become a popular buzzword today, especially at the corporate level. But vision at the project level is not well understood. Brown and Eisenhardt [5] state, "However, even though this aspect of project leadership is, we think, compelling, our understanding of exactly what vision is, what an effective product is, and the theoretical links between the two is very weak." The results of the present research indicate that the construct of visions or goals encompasses three distinct factors: (1) Goal Clarity, which includes a clear vision of the required features, target market, customer needs, and sales and business goals; (2) Goal Stability, which includes having a stable design and technical goal from pre-prototype through launch; and (3) Goal Support, which includes having team managers who support the project goals, securing an executive sponsor or champion, and having senior management help surmount rather than create obstacles. This study reinforces the argument that leaders can play a key role in ensuring that the goal of the project is clear, that it remains stable, and that resources are provided that help the team to reach its goal.

Goal Stability is also important regarding Speed. It was the practice that accounted for the most unique variance in Speed. This suggests that a stable goal is important in accelerating the development process. Changes to the goal can delay the project. This is similar to the adage that one of the authors encountered when running an R&D organization: We had a saying that "If you change one line on the specification drawing, you change the entire scope of the project." From personal interviews with Linda Gallager, President of Our Gang, a computer software company calls this "vision creep." By allowing the goal or vision to change, the project expands and the cost and time can increase dramatically. If the team can keep the goal stable, the team will be more likely to reach market quickly.

The IBM PC was an example of a vision that remained stable from the time the initial task force received the go-ahead until it was launched—it did not creep. In fact, when the PC team presented the final product release plan to IBM's senior management, most of the charts used during the initial task force proposal presentation were used again 1 year later for a presentation to the executive management committee just prior to launch. Lowe recalls:

> He [Don Estridge, the overall project manager] called me frequently and I remember the day he got approval to announce the project [to commercially launch it], he called and said, "What you'd be proud of is that of the charts we presented for approval, 80% of them are the identical same charts you used a year ago."

Goal Stability and NPD Process each accounted for unique variance in New Product Success. To be successful, the team must have a stable goal or vision of what they intend to achieve and a development process or plan on how to get there. An analogy of a traveler illustrates the relationship between Goal Stability and NPD Process. To get from point A to point B successfully, a traveler must have a stable destination in mind (Stable goal) and a roadmap (NPD Process) to help get there. Our results indicating the necessity of this "map" are consistent with previous research that has cited the importance of a NPD Process to New Product Success [7,8,13].

Our results, however, raise several questions. First, why were Recording and Filing found not to be significantly related to either Speed or Success? We believe this is because proficient Review incorporates both Recording and Filing. This assertion is supported by the significant correlations ($r = .40$) between Reviewing and these two variables. Although Recording and Filing may be important, they are complex variables and their importance may be lessened in the presence of Reviewing. The message to new product managers, however, is NOT to abandon filing and recording—these can be prerequisites to effective reviewing. It is far easier to review something that has been well documented and easily accessible than when it has not. A second question that emerges is, why were Goal Clarity and Vision Support not significantly related to Speed or Success, while Goal Stability was? One plausible explanation is because the effect of having a Clear Goal and Supported Vision is manifest in a Stable Goal. Again, the significant correlations between Goal Stability and both Goal Clarity ($r = .65$) and Vision Support ($r = .46$) attest to this assertion. Goal Stability incorporates the impact that these two variables have on Speed and Success. It is difficult to envision a situation where a new product team had a stable goal that was neither clear nor supported. If, on the other hand, a goal is unclear or not supported by top management or team leaders, then the goal would probably be unstable and experience changes as the project progressed. However, this argument does not mean that Goal Clarity or Vision Support is unimportant. It only demonstrates that in the presence of Goal Stability they do not account for a unique variance in either Speed or Success.

In today's technologically turbulent environments, companies must learn how to learn. This research has uncovered several learning practices that are both within a firm's control and are associated with accelerated NPD and overall new product success. Companies striving to create learning new product teams may want to explore these practices further in their own organizations

Future Research

Many important questions have surfaced that require additional study. One question that affects the building and testing of a model is how to address the issue of common variance among a set of learning practices. In the present study, Recording was significantly related to New Product Success, but when considered with the other six practices, it did not account uniquely for any significant variance in New Product Success. Does this mean that Recording is unimportant to new product success? Judgments about the importance of one practice are sensitive to other practices under consideration and intercorrelations among predictors of New Product Success. For example, Recording shared significant variance with NPD Process ($r = .49$) and NPD Process accounted for unique variance in New Product Success. Future research should analyze this model using a larger sample size combined with path analysis or structural equation modeling to further examine these relationships. Additional questions surface, including whether learning practices have both direct effects and indirect effects on Speed and Success, as well as if the product life cycle has a moderating effect on Speed and Learning. It is easy to envision that, during the early stages in the life cycle of a product class, learning may take longer because variables are unclear and learning is more exploratory. Later in the product's life, when more is known about the competitive environment, technological developments, preferred embodiments, and customer preferences, learning may proceed more quickly because there are fewer uncertainties. Future research should investigate the impact of product life cycle on team learning.

This investigation addressed team learning from members within their own team. It is, however, also reasonable to expect that teams learn from people external to the team—from other teams, as well as from competitors and customers. How can teams translate this external information into actionable knowledge? This question should be addressed in future research. Finally, many prior scholars have cited different success factors for incremental versus evolutionary versus radical innovation [33,54,55,58]. The question of whether different learning practices are needed for different innovation types (e.g., incremental, evolutionary, and radical innovations) is worthy of additional study. These questions just scratch the surface and indicate how the application of learning models to new product teams is a rich area for theory and research to improve innovation and enhance new product success rates.

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Appendix 1A. Factor Analysis of Learning Practices

Goal Clarity	
Pre-prototype, the overall business goals were clear.	.86
Pre-prototype, the sales goals were clear.	.83
Pre-prototype, the team had a clear vision of the target market.	.78
Pre-prototype, the team had a clear understanding of target customers' needs and wants.	.72
Pre-prototype, the team had a clear vision of required product features.	.71
Pre-prototype, technical goals were clear.	.57
Eigenvalue = 9.566	
Percent of variance explained = 31.9	
Recording	
Customer beta testing of prototypes were proficiently recorded.	.85
Market reactions to launched products were proficiently recorded.	.81
Customer reactions to early product concepts were proficiently recorded.	.62
Technical quality prototype test results were proficiently recorded.	.50
Eigenvalue = 3.871	
Percent of variance explained = 12.9	
Filing	
During the project, the above information could easily have been obtained on the same day requested.	.85
During the project, it would have been extremely easy to obtain the above information within the time needed.	.80
Today, people at the company could easily obtain the above information.	.64
A central file on this project was kept that included engineering changes made, prototype test results, and customer input/reaction to early concepts and launched products.	.63
Eigenvalue = 2.302	
Percent of variance explained = 7.7	
Reviewing	
During the project, at least weekly team staff meetings were conducted that included all department heads.	.82
During the project, team members systematically reviewed action items from team-staff meetings.	.76
During the project, team members systematically reviewed technical quality prototype test reports.	.68
During the project, team members systematically reviewed customer reaction reports on product concepts.	.66
Eigenvalue = 1.810	
Percent of variance explained = 6.0	
Good Stability	
The pre-prototype technical goals remained stable through launch.	.84
The pre-prototype design goals remained stable through launch.	.78
The pre-prototype vision of this project remained stable through launch.	.62
Eigenvalue = 1.556	
Percent of variance explained = 5.2	

Appendix 1A. Continued

NPD Process	
The team followed a clear plan—a road map with measurable milestones.	.76
Pre-launch, there were adequate mechanisms to track the project's progress.	.75
Pre-launch, there were adequate mechanisms to track the project's costs.	.67
Idea generation, screening and evaluation, development, testing, and launch were all completed.	.55
The above five phases in the new product process were proficiently completed.	.53
Eigenvalue = 1.300	
Percent of variance explained = 4.3	
Vision support	
Pre-launch, an executive champion/sponsor existed on this project.	.77
Overall, most senior company executives supported the vision of this project.	.74
Overall, senior company management helped surmount rather than create obstacles for this project.	.70
Overall, team managers supported the vision of this project.	.55
Eigenvalue = 1.233	
Percent of variance explained = 4.1	

Appendix 1B. Factor Analysis of Team Learning

Information Implementation	
Overall, the market perceived this product had fewer problems than what was considered normal in the industry.	.81
Most of the lessons learned pre-launch were incorporated into the product for full-scale launch.	.78
Post-launch, this product had far fewer technical problems than our nearest competitor's product.	.71
Overall, the team did an outstanding job uncovering product areas with which customers were dissatisfied.	.65
Eigenvalue = 2.789	
Percent variance explained = 39.8	
Information Acquisition	
Pre-launch, the did an outstanding job discovering technical shortcomings of this product.	.87
Pre-launch, the team did an outstanding job discovering manufacturing shortcomings.	.83
Eigenvalue = 1.283	
Percent variance explained = 18.3	

Appendix 1C. Factor Analysis of Speed to Market

Top management was very pleased with the time it took us to bring this product to market.	.90
Was launched on or ahead of the original schedule.	.82
Was completed in less time than what was considered normal and customary for our industry.	.77
Was developed and launched must faster than the major competitor for a similar product.	.76
Eigenvalue = 2.65	
Percent variance explained = 66.4	

Appendix 1D. Factor Analysis of New Product Success

Met or exceeded senior company management's expectations.	.93
Met or exceeded profit expectations.	.93
Met or exceeded return on investment expectations.	.92
Met or exceeded sales expectations.	.90
Met or exceeded customer expectations.	.88
Met or exceeded market share expectations.	.86
Met or exceeded technical performance expectations.	.63
Was launched within or under the original budget.	.60
Eigenvalue = 5.71	
Percent variance explained = 71.4	