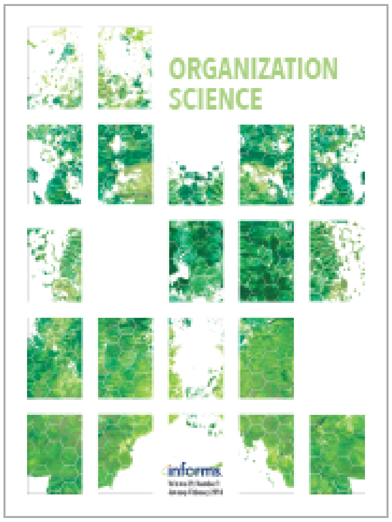

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Interteam Coordination, Project Commitment, and Teamwork in Multiteam R&D Projects: A Longitudinal Study

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Organizations increasingly set up multiteam projects for the development of highly complex products. While team research has emphasized the importance of team-internal processes for smaller scale projects, we know little about collaborative processes (especially between teams) in such large-scale projects. This study utilizes a multi-informant longitudinal research design on a product development project (39 teams, 36 months) in the European automotive industry investigating collaboration between and within teams. The results of the study demonstrate that interteam coordination, project commitment, and teamwork quality as rated by the team members at Time 1 (Month 12; end of concept phase) are significantly correlated to project managers' ratings of overall team performance at Time 3 (Month 36; end of project). The process variables measured at Time 2 (Month 24; end of design phase) display generally weaker correlations with team performance at Time 3. Multiple regression analyses further detail the effects of collaborative processes within and between teams on different measures of team performance (i.e., overall performance, quality, budget, schedule). The results show that collaborative processes during the project have predictive properties in regard to later team performance and can serve as early warning indicators. Furthermore, the results of this study provide support for our hypotheses predicting positive relationships between interteam coordination, project commitment, and teamwork quality. Theoretical and practical implications of this study are discussed.

Key words: team-based organizations; collaboration; R&D projects

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Companies have to innovate to remain competitive. They often rely on teams for the development of innovative products and services (Clark and Fujimoto 1991, Ancona and Caldwell 1992, Brown and Eisenhardt 1995). As innovations become more complex, however, they often exceed the capacity of one single team. For innovative projects such as the development of new automobiles, aircraft, and larger software solutions or computer hardware, hundreds of experts may be necessary (Cusumano and Selby 1995, Gerwin and Moffat 1997, Kazanjian et al. 2000). Certainly, these projects do not occur as frequently as smaller scale projects. However, considering their magnitude, they are of utmost importance not only to companies, but also to industries and national economies.

To cope with the complexities of such products, organizations usually split the product in its different modules and charge teams with the development of single modules, for instance, the transmission systems of a new automobile (Henderson and Clark 1990, Gerwin and Moffat 1997). This differentiation in modules aims at allowing specialist teams to develop their modules relatively independently from each other. However, as the project architecture usually corresponds to the product architecture, there are many interdependencies between the teams, which reflect the interplay between the modules of the product (von Hippel 1990, Kazanjian et al. 2000). Therefore, the modules have to add to another and need to be integrated to create the whole product (Van de Ven 1986). "To create a product with integrity requires a development process with integrity—activities must mesh in time and purpose" (Clark and Fujimoto 1991, p. 249). While factors in the project context (such as project planning, hierarchical coordination by project managers, standards, rules, information technology) will further integration, in dynamic environments, such as R&D projects, the direct, horizontal interaction between the teams is particularly critical (Mohrman et al. 1995).

It is the lateral collaborative processes occurring at the interteam level that are in the center of our study. The basic proposition of this research is that the level of interteam cooperation in multiteam projects influences the teams' ability to complete their design work on time and within budget and, thus, contribute their share that the overall project moves forward on schedule. Specifically, the following research questions are examined: (1) Is there an influence of interteam cooperation on team performance, above and beyond the influence of the team-internal collaborative process (teamwork)? (2) Should the intensity of collaborative processes (within teams and between teams) vary in different phases of a development project to increase team performance? (3) What is the relationship between external team processes and the internal team functioning?

Previous research on the context of multiteam projects has not provided sufficient answers to these questions. Prior studies on multiteam projects have either been descriptive in nature or focused on other issues: e.g., Sabbagh (1996) described the development of the Boeing 777 aircraft, and Cusumano and Selby (1995) gave insight into large-scale software development projects at Microsoft. Theoretical contributions have addressed task partitioning in large-scale projects (von Hippel 1990), authorizing processes and changing team autonomies (Gerwin and Moffat 1997), as well as creativity and learning (Kazanjian et al. 2000) in multiteam projects.

Moreover, existing research has consistently recognized the quality of collaboration *within* teams (i.e., teamwork) as an important factor to successful innovations (Clark and Fujimoto 1991, Cooper 1993, Nonaka and Takeuchi 1995, Hoegl and Gemuenden 2001). These conceptual models and empirical studies, however, primarily refer to smaller scale innovative projects where one team is sufficient to develop the desired new product, service, or process. While team researchers acknowledge the possible impact of the organizational context on team-internal processes and team performance (Gladstein 1984, Hackman 1987, Sundstrom et al. 1990, Tannenbaum et al. 1992), they have rarely investigated it specifically (for an exception, see Ancona 1990, Ancona and Caldwell 1990, Ancona and Caldwell 1992).

To conceptualize cooperation between teams, we considered research streams dealing with related issues: interdepartmental interaction (analyzing processes at interfaces, such as the R&D and marketing interface) and boundary spanning (referring to teams' interactions with outside groups). Based on the discussion in the literature, two aspects can be derived that can characterize cooperation between groups. On the one hand, when groups are interdependent and provide different parts to an overall product, they have to coordinate their workflows and contribute to overall integration (Lawrence and Lorsch 1967, Souder 1981, Gupta et al. 1986, Griffin and Hauser 1996). On the other hand, differentiation may cause strong group identities and an overemphasis of the group. This raises the issue that groups should keep in mind the superordinate goals of the organization and align their group goals to them (Schein 1969, Deutsch 1973, Brown 1983, Brown and Williams 1984, Ashforth and Mael 1989). Transferring these components to the context of multiteam projects, we conceptualize a team's cooperation with other teams by its coordination with other teams (i.e., synchronization of interdependent tasks and schedules) and its commitment to the project (i.e., identification with the overall project goals).

This research aims at furthering our understanding of the cooperative processes and effectiveness of teams in innovative multiteam projects. We derive hypotheses relating interteam coordination, project commitment, and (team-internal) teamwork to the task performance (quality, budget, schedule) of individual teams and to each other. Furthermore, we argue that collaborative processes on the team and interteam level are particularly important in the early phases of a development project. We test these hypotheses using data from a longitudinal multi-informant study (team members, team leaders, and project managers interviewed at three times during a 36-month period) on a large-scale development project in the European automotive industry (comprising 39 simultaneous engineering teams).

Constructs and Hypotheses

Team Performance

The conceptualization of team performance as a multidimensional construct is widely acknowledged in the literature (Hackman 1987, Pinto et al. 1993, Denison et al. 1996, Lechler 1997, Hoegl and Gemuenden 2001). In general, *team performance* can be defined as the extent to which a team is able to meet established objectives. In product development projects, specific dimensions of team performance include the adherence to predefined quality, schedule (time), and budget (cost) objectives. In the context of this study, *quality* refers to certain desired properties of the output produced by the team. For a product development team charged with designing a specific part of a larger product, several properties may be important, including functionality, manufacturability, durability and robustness, dimensional integrity, as well as optical and tactile attractiveness. Adherence to *budget* objectives refers to the costs associated with the team's development activities (i.e., personnel, prototype material, testing, and so on). As for *schedule* objectives, all teams in a multiteam project are included in an overall sequence of milestones (design reviews, and so on) where certain deliverables are expected at predefined times, which, in turn, provide necessary input for other teams.

Interteam Coordination and Team Performance

There are mainly two forces that create coordination needs between teams in multiteam projects: (1) task interdependencies and (2) changes occurring during the development process (Gerwin and Moffat 1997, Kazanjian et al. 2000).

Task interdependencies arise from the product architecture and refer to the intensity and direction of a workflow relationship between two teams (Gerwin and Moffat 1997, p. 301). As teams depend on other teams' input for accomplishing their own task, the work in one team has implications for the work and progress in other teams (e.g., what might improve the quality of one module might impede the functionality of another module). Therefore, technical details have to be synchronized (e.g., dimensions, weights, functionality, manufacturability, materials, tools to be produced) and connected activities have to be well timed to meet the given schedule and budget constraints (Sabbagh 1996). Without effective coordination between the teams, interdependencies might produce mistakes necessitating rework and creating crises (Loch and Terwiesch 1998, Kazanjian et al. 2000).

While the coordination requirements given by the project architecture right from the beginning of the project are calculable for the teams, the development of innovative products is always characterized by *changes*, which often affect the work of multiple teams. Changes may have several causes: prototype testing can reveal inconsistencies and can impose changes in the properties of a module and, in turn, require a new fine tuning with other teams (Souder and Moenaert 1992, Gerwin and Moffat 1997). Furthermore, the first concept of the project structure, including formal goals, resource allocations, and autonomies, is not necessarily perfect; in fact, it is often dynamically adjusted to new circumstances (Kazanjian et al. 2000). For example, a team might split into smaller work teams for more efficient teamwork. The changed structure might entail new allocations, interfaces, and so on. Similarly, environmental uncertainty concerning technologies, suppliers, or competitors might induce changes in the modules (Gerwin and Moffat 1997).

The high complexity and uncertainty of development processes, which are exacerbated by the strong interdependencies between teams and frequent changes, can only be dealt with if information is exchanged between the teams (Souder and Moenaert 1992). This offers opportunities for negotiations and compromises between the teams (Hinds and Kiesler 1995, Sabbagh 1996, Dutoit and Bruegge 1998, Madhavan and Grover 1998). Therefore, teams need to identify their interfaces and interdependencies with other teams and initiate an appropriate amount of coordination (Elmes and Wilemon 1991, Cusumano and Selby 1995).

The positive influence of coordination of interdependent groups or departments on the success of projects has been repeatedly confirmed in the literature (Ruekert and Walker 1987, Souder 1988, Hise et al. 1990, Moenaert and Souder 1990). Tushman (1977) showed that high levels of external interaction are necessary to successfully fulfill complex tasks. The study of Ancona and Caldwell (1992) revealed similar results: the integrative boundary spanning strategies "ambassador" and "task coordinator" were positively correlated with team performance. The stimulating effect of external communication on the success of teams has also been affirmed by Scott (1997) in her study of 42 product and process development teams as well as by Brown and Eisenhardt's (1995) review of the literature on product development.

We assume that the results of these studies also apply to the context of multiteam projects, where coordination with other teams can be fruitful in many respects. Although coordination with other teams might take time and resources, we argue that it has an overall positive effect on a team's ability to adhere to project schedules. The earlier and the more continuously task-relevant information is exchanged, the more likely the modules of the different teams will fit together in the end. Furthermore, if coordination between the teams is lacking (e.g., if changes are communicated too late or if the information is unclear), rework on certain work products (i.e., modules) is likely to be necessary. Such rework can become problematic, especially in later development phases and often entails delays and additional development costs (Hegazy and Khalifa 1996, Dutoit and Bruegge 1998). Moreover, coordination with other teams positively influences the quality of the team's output. As such, coordination offers the opportunity of exchanges with experts from other teams, where new perspectives and alternative ideas enter the team (Barczak and Wilemon 1991, Sethi 2000a). Design problems as well as possible solutions can be discussed together. Such an exchange of coordinative information regarding qualitative aspects of related modules ensures that the team's output fits connected parts in critical qualitative dimensions such as weight, size, durability, visual attractiveness, tactile attractiveness, and so on. Therefore, we conclude

HYPOTHESIS 1. *Coordination with other teams is positively associated with team performance.*

Project Commitment and Team Performance

Whenever two or more organizational groups interact for the purpose of superordinate goals, it is vitally important that they demonstrate a commitment to these overall goals (Souder 1981, Stephan 1985, Tjosvold 1988, Bartunek et al. 1996). Project commitment can be characterized by the acceptance of and the strong belief in the goals and values of the project, the willingness to engage in the project, and the desire to maintain membership in the project (Mowday et al. 1979, Mohr and Nevin 1990). "Commitment refers to a sense of duty that the team feels to achieve the project's goals and to the willingness to do what's needed to make the project successful" (McDonough 2000, p. 226; Ashforth and Mael 1989; Kline and Peters 1991). Such solidarity and identification with the project emerges, for instance, when the project members are fascinated by the innovative product and are proud of participating in its development. It is also influenced by strong interdependencies, colocation, and similarities between the teams (Ashforth and Mael 1989).

There is a natural tendency in teams to focus on their own team goals and to build strong intrateam cohesion. This problem should not be underestimated in multiteam projects. As the cooperation with other teams possibly leads to "unpleasant" constraints and difficulties in the development of their module (Kazanjian et al. 2000), teams might tend to ignore requirements of other teams on their module. Hence, they might consider their module isolated and optimize it without regarding technical interdependencies leading to technical incompatibilities with other teams' designs, which to resolve later in the project costs extra time and resources. The existence of project commitment in multiteam projects might minimize the harmful effects of potentially strong team identities and help overcome barriers between teams. In this case, project members draw a boundary around the project, not around their team (Kazanjian et al. 2000, Sethi 2000b). Commitment is not only associated with higher willingness to innovate and perform, it also decreases nonproductive behaviors such as job avoidance, defiance, or aggression (Reichers 1985, Locke and Latham 1990, Hunt and Morgan 1994). In their study, Klein and Mulvey (1995) found a strong relationship between goal commitment of a group and group performance. These results are confirmed by the research of McDonough (2000). Teams with strong project commitment focus on contributing to the overall project goals by developing a high-quality and well-integrated module within the given budget and schedule constraints. We conclude

Hypothesis 2. *Commitment to the overall project is positively associated with team performance.*

Teamwork Quality and Team Performance

In capturing the complex nature of team members working together, we use the teamwork quality construct as specified by Hoegl and Gemuenden (2001). In their study of software development teams, the within-team collaboration process was conceptualized and empirically validated as a multifaceted higher order construct. The six teamwork quality facets (communication, coordination, balance of member contributions, mutual support, effort, and cohesion) embrace elements of both task-related and social interaction within teams. The underlying proposition of this latent construct is that highly collaborative teams display behaviors related to all six teamwork quality facets.

Based on Hoegl and Gemuenden's (2001) detailed description of teamwork quality and its proposed linkage with team performance, we argue that teamwork quality has a positive influence on team performance in multiteam projects. For teams to better achieve their quality, time, and budget objectives, team members should openly communicate relevant information (Katz and Allen 1988, Hauptman and Hirji 1996), coordinate their individual activities (Adler 1995, Faraj and Sproull 2000), ensure that all team members can contribute their knowledge to their full potential (Seers 1989), mutually support each other in team discussion and individual task work (Tjosvold 1984, Cooke and Szumal 1994), establish and maintain work norms of high effort (Hackman 1987, Weingart 1992), and foster an adequate level of team cohesion where team members maintain the group (Mullen and Copper 1994, Gully et al. 1995). It should be noted that although research on the performance effect of team cohesion is not entirely conclusive (see Janis 1995, for the detrimental effects of the groupthink phenomenon in the case of very high levels of cohesion, particularly for long-standing groups), a metanalysis by Gully et al. (1995), including 46 empirical investigations demonstrated that cohesion positively influences performance, particularly if the team task requires coordination and communication (e.g., innovative tasks). Another metanalysis by Mullen and Copper (1994), including 49 empirical studies also concluded an overall positive relationship between team cohesion and performance chiefly based on task commitment rather than group pride.

We argue that the quality of teamwork is likely to increase the performance of teams in multiteam projects as it has shown to increase performance in single team projects (Hoegl and Gemuenden 2001, Sethi and Nicholson 2001). Strong internal team collaboration allows team members to contribute their knowledge and skills to both technical issues as well as matters of task planning and controlling, thus, increasing the team's ability to produce a high-quality module on time and within budget. Hence, we propose the following:

Hypothesis 3. *Teamwork quality is positively associated with team performance.*

Interteam Coordination and Teamwork Quality in Different Project Phases

The general effects of interteam coordination and teamwork on team performance notwithstanding, previous research indicates that there are different phases in the course of an innovative project, which require specific behaviors (Ancona and Caldwell 1990, Souder and Moenaert 1992). For a project team to be successful, it has to adjust its level of interaction (internally and externally) to the specific need for interaction. While an adequate level of project commitment seems to be beneficial at any point in time, we suppose that the importance of interteam coordination and teamwork quality varies with the phase of a project.

Following Souder and Moenaert (1992), we distinguish between the early concept stage (also called planning, idea generation, or creation stage) and the later design stage (also called execution or problem-solving stage) (Tushman 1977, Adams and Barndt 1983, Pinto and Prescott 1988, Ancona and Caldwell 1990). In the concept phase, uncertainty is particularly high. To reduce uncertainty and move from a team task with low analyzability and high variability to a task with higher analyzability and lower variability, the teams need to gather and process information (Souder and Moenaert 1992). The teams are asked to determine other teams' expectations, interdependencies between modules, and possible constraints and opportunities. Furthermore, the teams should have a common understanding of what their modules can and should be. Hence, interteam coordination in the concept stage (which includes discussing innovative ideas with other teams, identifying alternatives together, "selling" own ideas to other teams to gain their support), helps the teams reduce uncertainty, solve problems, and establish goals (Pinto and Prescott 1988, Ancona and Caldwell 1990, Kloppenborg and Petrick 1999). Correspondingly, it has been shown that intensive cross-functional teamwork (within teams) early in the project sets the course for later team success (Gupta and Wilemon 1990, Clark and Fujimoto 1991, Verganti 1997). The broad knowledge base existent in cross-functional teams is more likely to transfer into creative and comprehensive concepts in the early project phase if there is a high degree of teamwork quality.

In the later design phase, plans and concepts need to be transformed into reality and, therefore, actual task work needs to be performed (e.g., design and construction of the prototypes). The teams have to efficiently exploit the information gathered in the first phase and spend their time mainly on technical tasks (Tushman 1977, Pinto and Prescott 1988, Ancona and Caldwell 1990). Inputs from outside should be adequately restricted (Souder and Moenaert 1992) to avoid overloading the team with other teams' priorities and suggestions, and prevent it from moving forward according to schedule. This does not mean that coordination with other teams is not necessary anymore. New uncertainties or unexpected events might occur, which might affect the teams' work. However, modifications should only be made when really required (Adams and Barndt 1983), and interteam coordination should be focused on the exchange of indispensable information (radically changing outputs, schedules) rather than creative discussions. In the design phase, there is less need for intensive cooperation between team members. With the basic design being already determined, the technical tasks can be more efficiently executed in detail by individuals or small groups in their respective areas (Kloppenborg and Petrick 1999). Therefore, we conclude

HYPOTHESIS 4A. *Interteam coordination in the early phase of an innovative project influences team performance to a greater extent than interteam coordination in the later project phase.*

HYPOTHESIS 4B. *Teamwork quality in the early phase of an innovative project influences team performance to a greater extent than teamwork quality in the later project phase.*

As mentioned above, we do not argue for a phase-specific hypothesis regarding project commitment, as the relevant literature does not provide any indication for that, and we do not believe that project commitment may be exceptionally important to team performance in any specific phase of the project.

Interteam Coordination, Project Commitment, and Teamwork Quality

The relationship between team-internal and team-external cooperative processes has not received much direct study and, moreover, is quite ambiguous (Ancona 1990). While previous literature on inter-group relations assumed a negative relationship between collaboration within and between groups (Guzzo and Shea 1992, Lichtenstein et al. 1997), recent team studies indicate that teams seem to be able to be both internally and externally active.

Ancona (1990) found in her study on consulting teams that teams focusing on external activities at the beginning of the project lacked internal cohesion in the short run. However, based on an affirmative interaction with their environment, internal processes improved. In a similar vein, Gersick (1988) noticed that teams deal with internal and external requirements sequentially (and not simultaneously). Hence, teams seem to specifically meet internal and external needs, depending on the stage in their life cycle. Other researchers, however, argue that groups can realize good collaboration within and outside simultaneously. Nelson (1989, p. 388) stated that "...strong within-group ties are actually beneficial to organizational harmony if balanced by a number of strong ties linking groups. It might be argued that strong ties help to maintain harmony inside groups, thus, contributing to overall harmony in an organization." Labianca et al. (1998) point out that based on their own internal relationships, groups develop a positive or negative cognitive frame and, accordingly, project their own in-group attributions to their relationship with outside groups or vice versa.

We argue that interteam coordination, project commitment, and teamwork quality are positively reinforcing each other in the context of multiteam projects, where the teams are required to cooperate to complete their work effectively and efficiently.

First, we propose that there is a positive relationship between intrateam collaboration (i.e., teamwork quality) and interteam coordination. This can be explained by the cross-functional nature of product development teams, where team members belong to different social and organizational groups—occupations, age cohorts, genders, and so on—and who identify with these groups (Alderfer 1987). Referring to the R&D-marketing interface, Griffin and Hauser (1996) concluded that there are many barriers that hinder functional groups from cooperating, such as different stereotypes, cultural thought worlds, languages, organizational responsibilities, and physical barriers. To achieve high levels of teamwork quality, cross-functional teams need to overcome these barriers and integrate different goals, priorities, and views. Team members who succeed in tackling these intrateam challenges and achieve high within-team collaboration are also likely to recognize the need for cooperation with other teams. We assume that teamwork quality is a general indicator of a team's ability for task-related interaction and networking. Therefore, teams possessing the ability for strong within-team (cross-functional) collaboration are also likely to arrange their own goals with other teams' objectives to ensure their team's performance and overall project success. This "spillover effect" between the quality of relationships within a group and with other groups (Labianca et al. 1998, Keenan and Carnevale 1989) is also likely to occur the other way round. As previously mentioned, Ancona (1990) showed that teams that are engaged in positive interaction with outside groups were able to strengthen their intrateam relationships across time. Hence, good interteam coordination can be expected to support collaboration within the team.

Second, we expect a positive association between teamwork quality and project commitment. As teams develop commitment to the project, they are likely to refocus and sharpen their team-internal commitment and engage in within-team collaboration to ensure their contribution to the project. As such, the teams' recognition of how the overall project's success depends on their contributions is likely to affect their level of teamwork. Likewise, a high degree of teamwork quality within the team can positively influence project commitment. This rationale draws on the research on organizational commitment, arguing that situational factors related to the job setting (such as climate, job involvement, job attachment, opportunities for social interaction, satisfaction) promote global organizational commitment (Steers 1977, Reichers 1985, Hunt and Morgan 1994). As Morris and Sherman (1981, p. 519) note, "...work circumstances that fulfill individuals' growth and achievement needs may yield organizationally positive employee attitudes and levels of involvement." As such, teams whose members experience a high level of teamwork quality (i.e., mutual support, cohesion, and so on) are likely to develop commitment to the larger organizational context (i.e., the project) they are embedded in. Moreover, as team members invest their energy in collaboratively ensuring their team's task performance, they may well become increasingly motivated to see that the overall project they are contributing to is also successful. Thus, team-level collaboration may, across time, influence team members to extend their commitment beyond their teams' modules to the overall project.

Third, we assume that interteam coordination and project commitment positively influence each other. If teams feel committed to the project, i.e., share superordinate goals, they are likely to develop mutual psychological acceptance and cohesion in the project (Tjosvold 1988, Ashforth and Mael 1989, Sethi 2000b, Williams 2001). Thus, project commitment creates a positive mood that motivates teams to engage in cooperation with other teams. Information is more willingly exchanged, perspectives of other teams are considered in decision making, and innovative ideas are more likely to be discussed with other teams. Teams with high levels of project commitment are motivated to engage in interteam coordination for the success of the project and to contribute their part. Correspondingly, strong interteam coordination can, across time, promote project commitment among the teams (Allen 1996). When teams coordinate, they will perceive a common fate and mutual dependency that can focus them on the common project. Furthermore, as Sethi (2000b) notes, the sharing of experiences and socialization can create a bond among the project members with increasing project duration.

In summary, we propose

Hypothesis 5a. *Teamwork quality and coordination with other teams are positively related.*

Hypothesis 5b. *Teamwork quality and project commitment are positively related.*

Hypothesis 5c. *Project commitment and coordination with other teams are positively related.*

Methods

Research Setting

This study was conducted in a new product development project in the European automotive industry. The new product was an innovative addition to the models the firm previously produced, and was intended to ensure competitiveness and growth. The total budget for this development project was approximately (U.S.) $500 million. The project we investigated included a total of 39 cross-functional teams that were colocated in one building. They consisted of members from different functions, such as engineering, quality management, controlling, purchasing, logistics, marketing, planning, and so on, and had an average size of nine team members. Some teams also included employees from supplier organizations, however, they acted as consulting team members rather than core team members as they did not participate in daily work. Therefore, we excluded them from data gathering.

The 39 teams were divided into 8 subprojects each headed by a project manager, who, in turn, reported to the project director responsible for the entire project. Based on the initial product design, project managers defined module specifications (in terms of schedule, budget, and quality) for each team, thus, assigning team responsibilities within the project. The teams had the responsibility and authority to make task-related decisions within this given scope. The teams had to, however, obtain approval from their project manager on far-reaching decisions (e.g., decisions that involved changes affecting a number of other teams). The project managers' job was to ensure that the overall product specifications were met. Therefore, they continuously monitored the progress of the teams and the overall project without exerting tight control. To this end, project managers set specific project milestones, at which design reviews were conducted.

Consistent with the company's guideline to grant as much autonomy as possible to the teams, the project managers practiced a leadership style best described as "management by exception." Unless there were conflicts between or within teams that they could not solve by themselves, the project managers did not interfere in interteam or intrateam processes. While project management provided the teams with an appropriate infrastructure (i.e., information technologies, meeting rooms, and so on), to further communication within the project, it was up to the teams to ensure proper interteam coordination, including identifying technically related teams. Overall, there was a rather cooperative climate within the project, as evident from a number of comments by project members reporting a "generally positive atmosphere." At the same time, however, many project members also emphasized in their comments, a certain "tension level" resulting from the ambitious project objectives, most notably an aggressive project schedule.

Data Collection

Team members were randomly chosen for this study. Respondents' participation in this study was strictly voluntary. All contacted respondents were interviewed. Data were gathered by the authors and research assistants in individual interviews using a fully standardized questionnaire (five-point answer scale). All interviews were conducted on site in dedicated interview rooms, assuring similar conditions for each interview. The interviews followed a very structured pattern. After a brief introduction of the study, the questionnaire was handed to the respondent to complete by reading it himself or herself. This way, possible interviewer effects were minimized while there was still an interviewer present to clarify questions if any occurred.

This study is based on a longitudinal multi-informant research design. Data were gathered from different levels of this project organization: team members (including formal team leaders) and project managers. To ensure content validity and to avoid a possible common source bias, data from different respondents were used to measure the different variables. Team performance was assessed using data from project managers, while the process variables (interteam coordination, project commitment, and teamwork quality) were measured using responses from multiple team members (including formal team leaders).

The data were gathered at 3 times in the 36-month duration of the project. The first data collection (Time 1) was conducted in a time span of about 6 weeks in Months 12 and 13 of the project, followed by a second round of data collection (Time 2) in Months 23 and 24. A third round of data collection (Time 3) occurred in Month 36 gathering team performance ratings from project managers. These data collection times were chosen in accordance with the project's main milestones, where Time 1 marked the conclusion of the concept phase, Time 2 marked the conclusion of the design phase, and Time 3 marked the conclusion of the testing and production preparation phase.

The database for the following analyses is made up of 222 responses from members of all 39 teams at Time 1 and at Time 2 (i.e., the same respondents were interviewed at both times regarding the same team), as well as 39 project manager ratings of team performance at Time 3.

Measures

The questionnaire was administered in the language of the country where the research setting was situated. Translations of the items used in the following analyses are included in the Appendix of this paper. Most items were specifically generated or adapted for the present study based on the discussions of these constructs in the literature.

The measurement scale for *interteam coordination* (Cronbach's alpha $= 0.85$) consists of five items on the quality of coordination and operating characteristics between the teams (e.g., constructive discussions). These items were partly adapted from the scales used by Mott (1972) who evaluated coordination, communication, and cooperation between different occupational groups in hospitals. The five-item scale assessing *project commitment* (Cronbach's alpha $= 0.75$) addresses how positively team members relate to the overall project and its objectives (Pinto et al. 1993). We ran exploratory factor analyses with the items of interteam coordination and project commitment, respectively, to confirm the internal consistency of these two scales. Using the Kaiser criterion, the factor analyses resulted in one-factor solutions for both interteam coordination and project commitment.

The *teamwork quality* construct was measured using items from the Hoegl and Gemuenden (2001) study on software teams. For the purpose of this investigation, some of their scales were shortened to include fewer items, and some items were adapted to the present research context. Teamwork quality was measured using between 2 and 5 items per teamwork quality facet (Cronbach's alpha between 0.70 and 0.89) with a total of 20 items for all 6 facets (i.e., communication, coordination, balance of member contributions, mutual support, effort, and cohesion). Following the steps by Hoegl and Gemuenden (2001), a series of factor analyses at the individual level ($N = 222$) were conducted to verify teamwork quality as a high-order construct. First, all six teamwork quality facets were factor analyzed to assess internal consistency. Using the Kaiser criterion, one factor was extracted. The reliability analysis confirms a high level of internal consistency with a Cronbach's alpha coefficient of 0.88. Second, to account for possible dependencies of observations within one team, we have regressed every teamwork quality facet on group, saved the standardized residuals and entered those in another factor analysis. Again, one factor was extracted using the Kaiser criterion. Furthermore, we followed the procedures suggested by Henik and Tzelgov (1985) to control for a possible halo effect, whereby team members' general sense of their team's task success may have caused them to give correlated ratings across the teamwork quality facets. We have regressed standardized residuals from the group effect procedure above on the first item of the overall performance scale as a general indicator for task success ("Going by the results so far, this team can be regarded as successful."). The standardized residuals ("purified" from group effect and halo effect) were saved and used as input for another factor analysis at the individual level ($N = 222$). Again, a one-factor solution for the six teamwork quality facets emerged, indicating that the six teamwork quality facets pertain to the same latent construct.

The measurement scales for team performance were partly based on the scales used by Lechler (1997) and Hoegl and Gemuenden (2001). To capture team performance, we have used both a scale assessing overall team performance, as well as detailed measures evaluating important performance dimensions such as product quality, adherence to budget, and adherence to schedule. The scale assessing *overall performance* consists of five items (Cronbach's alpha $= 0.90$) referring to the team's task performance in relation to all schedule, budget, and quality objectives. The seven-item scale for *quality* (Cronbach's alpha $= 0.89$) focuses on technical properties of the module a team was chartered to design and develop (e.g., dimensional integrity, durability, functionality, and so on). The three-item scale measuring the teams' *adherence to budget* (Cronbach's alpha $= 0.78$) addresses development costs incurred (e.g., prototype costs). The teams' *adherence to schedule* is expressed as the project managers' evaluation of how many weeks a team is behind or ahead of applicable project schedules. We have inverted this measure to represent better adherence to schedule by higher numbers.

Prior to aggregating team members' evaluations of interteam coordination, project commitment, and teamwork quality, interrater agreement (James 1982, James et al. 1984, Campion et al. 1993) was assessed using the multiple item estimator for within-group interrater reliability as proposed by James et al. (1984). This test yielded results indicating generally very strong agreement of ratings referring to the same team. The average score of this test across all teams is 0.90 for interteam coordination, 0.91 for project commitment, and 0.93 for teamwork quality. Given this homogeneity of within-team ratings, data were aggregated by calculating the arithmetic mean.

Provided the longitudinal nature of this study, we have tested the data for possible differences in means and variances between process variables at Time 1 and Time 2. No significant differences were found for any of the variables. Further, correlations of the process variables at Time 1 and Time 2 indicate a certain degree of stability over time (interteam coordination $r = 0.55$, project commitment $r = 0.58$, teamwork quality $r = 0.47$). However, the magnitude of these temporal relationships is somewhat striking. For instance, interteam coordination at Time 1 explains about 30% of the variance of that variable as rated by the same individuals at Time 2. Thus, these results show that in longer projects of the kind investigated here, the perceptions of the intensity of processes such as interteam coordination, project commitment, and teamwork quality vary considerably over time.

Regarding the evaluations of team performance, it is important to note that project managers' perceptions of overall performance are strongly correlated with their perceptions of quality ($r = 0.55$) and adherence to schedule ($r = 0.39$), but much less with adherence to budget ($r = 0.21$). Regression analysis confirms this finding, showing only quality and adherence to schedule as statistically significant influences. This documents that project managers rely more heavily on quality and time when making overall performance evaluations, while taking budget issues less into consideration. This may highlight a certain goal hierarchy in this project, where project managers repeatedly stressed quality and time as highly critical. In personal interviews, project managers described the development budget as very important, but indicated that they would compromise budget performance for quality and time if necessary.

Data Analysis

The longitudinal multi-informant design of this study allows for temporal spacing of cause and effect. As described above, we are using measures of the process variables (interteam coordination, project commitment, and teamwork quality) at Time 1 and Time 2 (team ratings at both times), while we are considering team performance (manager ratings) at Time 3. We have conducted correlation and regression analyses in testing our hypotheses. All analyses are conducted at the team level ($N = 39$). Given the limited N at the team level, and provided that we have included all teams of this population, we are considering 10%, 5%, and 1% significance levels.

In addition to the regression analyses on the basis of all 39 teams, we have conducted further regression analyses, exploring the possible effects of the level of task interdependency on the relationships between the process variables (interteam coordination, project commitment, and teamwork quality) and the team performance variables. These additional exploratory analyses are based on the assumption that for teams with high task interdependencies (i.e., a high number of technical interfaces with other teams), collaborative processes within and between teams may be more important than for teams with low task interdependencies (i.e., teams that can work relatively autonomously). To classify teams into "low" and "high" task interdependency, we have asked team leaders at Time 1 to document the number of technical interdependencies (interfaces) of their teams with other teams in the project. Using a median split, we have identified 20 teams for the low task interdependency category and 19 for the high task interdependency category.

Results

Correlations Between Process Variables and Team Performance

We have first conducted correlation analyses to test the proposed bivariate relationships between interteam coordination, project commitment, teamwork quality, and the team performance measures employed. As documented in Table 1, all three process variables measured at Time 1 show a strong correlation with overall team performance (teamwork quality $r = 0.48$, interteam coordination $r = 0.35$, project commitment $r = 0.35$). This influence becomes much weaker when considering the process variables at Time 2. Teamwork quality is no longer significantly correlated ($r = 0.14$). Interteam coordination ($r = 0.27$) and project commitment ($r = 0.21$) remain significantly correlated, although with slightly lower coefficients as compared to Time 1 data.

Of the detailed measures, adherence to schedule seems most impacted by all three process variables. Considering the measurements at Time 1, teamwork quality ($r = 0.49$), interteam coordination ($r = 0.57$), and project commitment ($r = 0.27$) are positively correlated with adherence to schedule at Time 3. As with overall performance, teamwork quality measured at Time 2 is no longer a significant influence on adherence to schedule ($r = 0.20$). Interteam coordination ($r = 0.44$) and project commitment ($r = 0.38$), however, remain strongly correlated with adherence to schedule. It is worth mentioning that the influence of project commitment has increased from Time 1 to Time 2, whereas interteam coordination and, most notably, teamwork quality show reduced correlations. Adherence to budget at Time 3 has only one significant correlation with the process variables, documenting a negative (!) influence of interteam coordination at Time 1 ($r = -0.25$). This finding contradicts the hypothesized positive influence of interteam coordination on budget performance. The quality of the outcome produced is significantly correlated with only one process variable, showing a positive influence of project commitment at Time 1 ($r = 0.21$).

All in all, the correlation analyses provide mixed results. While the evidence on the basis of the over-

Table 1 Descriptive Statistics and Intercorrelations

	Time	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9
(1) Interteam coordination	1	3.23	0.32									
(2) Project commitment	1	3.57	0.43	0.28*								
(3) Teamwork quality	1	3.67	0.41	0.67**	0.39**							
(4) Interteam coordination	2	3.10	0.36	0.55**	0.21+	0.25+						
(5) Project commitment	2	3.45	0.47	0.30*	0.58**	0.27*	0.51**					
(6) Teamwork quality	2	3.63	0.37	0.25+	0.08	0.47**	0.28*	0.30*				
(7) Overall performance	3	3.80	0.39	0.35*	0.35*	0.48**	0.27*	0.21+	0.14			
(8) Quality	3	3.76	0.44	0.13	0.21+	0.08	0.15	−0.01	−0.09	0.55**		
(9) Adherence to budget	3	2.84	0.95	−0.25+	0.02	−0.04	−0.17	−0.02	−0.04	0.21	0.15	
(10) Adherence to schedule	3	6.11	5.01	0.57**	0.27+	0.49**	0.44**	0.38**	0.20	0.39**	0.27+	0.06

Note. ** = significant at the 0.01 level.
* = significant at the 0.05 level.
+ = significant at the 0.10 level.
$N = 39$ teams.

all performance ratings largely supports the proposed positive influences of interteam coordination, project commitment, and teamwork quality, the results for the detailed performance measures offer a more diverse picture. Schedule performance is positively related with all three process variables, but quality and budget performance are only influenced by project commitment (Time 1) and interteam coordination (Time 1), respectively. Furthermore, there seems to be an overall trend that the process variables at Time 1 are more influential than the measures of the process variables taken at Time 2. This provides some support to our proposition that collaboration is particularly important in the early project phase. For example, the difference between the correlation coefficients for teamwork quality at Time 1 with overall performance and teamwork quality at Time 2 with overall performance is statistically significant at the 5% level. The corresponding comparison for adherence to schedule is significant at the 10% level. The correlations of interteam coordination measures at Time 1 and Time 2 also show a declining tendency for both overall and schedule performance, but those differences are not statistically significant.

Regression Analyses on the Influence of the Process Variables on Team Performance

We have conducted a series of multivariate regression analyses to further test the influence of the three process variables on team performance. Collinearity statistics (i.e., variance inflation factor) calculated for all regression analyses do not indicate distortions of results due to correlations among regressors.

First, using the data from all 39 teams, we have regressed the performance measures at Time 3 (overall, quality, budget, schedule) on the three process variables at Time 1. As documented in Table 2, teamwork quality shows a strong positive influence on overall team performance, while interteam coordination and project commitment are not significant in this multivariate analysis. Interteam coordination has a significant negative influence on the teams' ability to adhere to budgets, thus, contradicting our hypothesis and confirming the bivariate correlation results. Further, interteam coordination remains the only significant influence on adherence to schedule. There is no significant influence of project commitment at Time 1 on any of the performance measures.

Table 2 Results of Regression Analyses

Regressing Performance at Time 3 on Process at Time 1

	Overall Performance			Quality			Adherence to Budget			Adherence to Schedule		
	Standard Coefficients			Standard Coefficients			Standard Coefficients			Standard Coefficients		
	All	High TI	Low TI	All	High TI	Low TI	All	High TI	Low TI	All	High TI	Low TI
Interteam coordination	0.04	−0.07	0.19	0.13	−0.16	0.12	−0.41*	−0.79*	−0.30	0.43*	0.65*	0.09
Project commitment	0.20	0.07	0.43*	0.21	0.24	0.22	0.06	0.10	0.11	0.06	0.07	−0.15
Teamwork quality	0.38*	0.58*	0.14	−0.09	0.31	−0.29	0.21	0.56+	0.00	0.17	0.07	0.36
R-square	0.27	0.31	0.32	0.05	0.12	0.06	0.10	0.22	0.10	0.35	0.54	0.15
F	4.27	2.40	2.40	0.63	0.72	0.31	1.25	1.54	0.55	5.84	6.36	0.89
p	0.01	0.11	0.11	0.60	0.55	0.82	0.31	0.24	0.66	0.00	0.01	0.47

Regressing Performance at Time 3 on Process at Time 2

	Overall Performance			Quality			Adherence to Budget			Adherence to Schedule		
	Standard Coefficients			Standard Coefficients			Standard Coefficients			Standard Coefficients		
	All	High TI	Low TI	All	High TI	Low TI	All	High TI	Low TI	All	High TI	Low TI
Interteam coordination	0.22	0.39+	0.02	0.24	0.15	0.29	−0.22	−0.41	−0.01	0.32	0.58*	0.09
Project commitment	0.09	−0.12	0.33+	−0.10	−0.22	0.10	0.10	0.21	−0.08	0.21	−0.11	0.33+
Teamwork quality	0.05	0.23	−0.26	−0.12	0.01	−0.19	−0.01	−0.01	0.12	0.03	0.13	−0.03
R-square	0.09	0.22	0.14	0.05	0.03	0.13	0.04	0.11	0.02	0.23	0.33	0.12
F	1.08	1.53	0.80	0.56	0.17	0.72	0.43	0.65	0.09	3.24	2.68	0.67
p	0.37	0.25	0.51	0.65	0.92	0.56	0.73	0.60	0.97	0.03	0.08	0.58

Note. ** = significant at the 0.01 level.
* = significant at the 0.05 level.
+ = significant at the 0.10 level.
All = all teams; $N = 39$.
High TI = teams with high task interdependencies with other teams; $N = 19$.
Low TI = teams with low task interdependencies with other teams; $N = 20$.

Second, again using the data from all 39 teams, we have regressed team performance measured at Time 3 on the three process variables measured at Time 2. The results show only one significant influence. Interteam coordination at Time 2 impacts schedule performance at Time 3, thereby confirming the correlation results. Surprisingly, given the results of the correlation analyses, none of the three process variables measured at Time 2 has a significant effect on overall performance.

The results of the regression analyses provide support for our Hypothesis 4b, proposing that teamwork quality in the early project phase is particularly influential in determining later team performance. While teamwork quality at Time 1 shows a strong influence on overall team performance at Time 3, teamwork quality in the middle phase of the project (Time 2) has virtually no association with overall team performance. As for interteam coordination, the results of the regression analyses support the findings of the correlation analysis, showing that interteam coordination is important in both the concept and the design phase of the project. In particular, we find that interteam coordination at Time 2 remains a significant predictor of schedule performance, while its negative influence on budget performance is reduced. Consequently, these results offer no support for our Hypothesis 4a, suggesting a greater influence of interteam coordination in the early phases.

As additional exploratory analyses, we have run the regression analyses separately for two categories of teams, which we termed "high task interdependency" and "low task interdependency," to assess whether a team's number of technical interfaces with other teams has any influence on the performance effects of the three process variables. The results from these exploratory analyses reveal two noteworthy patterns (see Table 2). First, many of the findings in the full population ($N = 39$) seem amplified in the high task interdependency teams. For instance, the positive effect of interteam coordination at Time 1 on schedule performance increases from 0.43 to 0.65; likewise for teamwork quality's influence on overall performance (0.38 to 0.58), quality (−0.09 to 0.31), and adherence to budget (0.21 to 0.56). Second, project commitment at Time 1 becomes a significant predictor of overall performance at Time 3 when considering only the low task interdependency teams. For those teams, project commitment is also important at Time 2, where it shows a significant effect on overall performance and adherence to schedule at Time 3.

Relationships Between the Process Variables

To test Hypotheses 5a, 5b, and 5c relating interteam coordination and project commitment to teamwork quality, as well as project commitment to interteam coordination, we examined the correlations between these variables. As documented in Table 1, both interteam coordination and project commitment are significantly correlated to teamwork quality both at Time 1 and Time 2, providing support to our Hypotheses 5a and 5b, suggesting positive relationships between within-team collaboration and team members' external interactions and project-level commitment. Furthermore, project commitment and interteam coordination show significant positive correlations at both Time 1 and Time 2, supporting our Hypothesis 5c.

Discussion

This study investigated how processes at the team and the interteam level influence the performance of teams in a large-scale, multiteam innovation project. Using a longitudinal multi-informant research design on all 39 teams of a 36-month new product development project, we related the teams' ratings of the process variables (interteam coordination, project commitment, teamwork quality) at Time 1 (Month 12) and Time 2 (Month 24) to the managers' evaluations of team performance (overall performance, quality, adherence to budget, adherence to schedule) at Time 3 (Month 36). Furthermore, we have related interteam coordination and project commitment to the quality of collaboration within teams (teamwork quality), as well as project commitment to interteam coordination.

Theoretical Implications

Hypothesis 1 proposed a positive relationship between interteam coordination and team performance. Our results support this proposition regarding project managers' perceptions of overall performance. Thus far, this study confirms prior research on the influence of coordination of interdependent groups or departments on the success of projects (Ruekert and Walker 1987, Souder 1988, Hise et al. 1990, Moenaert and Souder 1990). Considering the correlations between interteam coordination and the detailed scales of team performance, this relationship is primarily due to interteam coordination's positive impact on schedule performance. Of the detailed performance measures, only adherence to schedule shows a significant positive relationship. Quality is not influenced by interteam coordination, and adherence to budget is negatively (!) associated with interteam coordination. These missing or reversed relationships pose interesting questions regarding likely explanations.

It is possible that the negative influence of interteam coordination on adherence to budget reflects the resource consuming nature of interteam coordination. Hence, while interteam coordination enables the team to ensure that schedules are being met, it may also drive up development costs as coordinative activities require team members' time commitment ("keeping them in meetings rather than at work") and uncover further testing requirements or necessary changes/adaptations to current designs. As such, this finding may offer support to earlier research (Tushman 1977, Clark and Fujimoto 1991, Loch and Terwiesch 1998).

The lack of influence of interteam coordination on quality is also not altogether surprising, as coordination with other teams (i.e., related modules) may, at times, mean finding compromises between one's own design preferences and the requirements of related modules. For instance, while interteam coordination improves a team's ability to adhere to "interface requirements" with other parts, heat emissions, space requirements, and other technical influences from related modules may result in what is on the team level perceived as a suboptimal compromise between, for instance, durability and weight of one team's module. On the project or system level, such compromises are mostly necessary and positive regarding the overall product, the properties of the finished car.

As our exploratory analyses show, interteam coordination is particularly critical for teams that have technical interfaces with a high number of other teams (i.e., high task interdependency). For those teams, interteam coordination is crucial in the early project phases and remains important during the middle phase of the project. This is consistent with the study of Ancona (1990), who found that teams depending on outsiders and facing new, unstructured tasks were rated as the highest performers if they emphasized an "external probing" strategy. Teams with low task interdependencies, by contrast, are less dependent on interteam coordination to ensure team performance.

Regarding Hypothesis 4a, these results provide no support for our proposition that interteam coordination be particularly important in the early phase. Rather the findings underline that the coordination between teams remains important due to unforeseen changes as the teams proceed to implement their concepts and design their modules.

In sum, interteam coordination in the early and middle stages of a complex innovation project is important to move the project forward as scheduled, which is crucial for time-to-market planning and may, therefore, often outweigh increases in development budgets. It should be reminded that project managers' ratings of overall team performance are strongly correlated with adherence to schedules. Furthermore, while interteam coordination may have both positive and negative effects on individual module quality, it seems safe to assume that the exchange of important technical data ultimately helps to optimize quality on the system or project level.

Hypothesis 2 proposed a positive relationship between project commitment and team performance. The results of this study lend partial support to this proposition, showing that project commitment in the early and middle phases of the project is positively correlated with overall performance. Thus far, our results confirm prior research by Klein and Mulvey (1995) as well as McDonough (2000). The multivariate regression analyses on all 39 teams, however, show no significant influence of project commitment on any performance variable. It is possible that relationships between the process variables account for the missing direct influence of project commitment when also considering interteam coordination and teamwork quality. We argued earlier in this paper that the three process variables are mutually reinforcing one another. The significant positive correlations between these variables at both Time 1 and Time 2 support this notion. As such, it is plausible to assume that project commitment may exert an indirect influence on team performance through its relationship with both interteam coordination and teamwork quality. From this perspective, project commitment may provide a good angle for project managers to influence the quality of interactions within and between teams by working to foster commitment to project goals.

A direct effect of project commitment on team performance, however, is supported by the results of our exploratory analyses dividing the sample into low and high task interdependency teams. These results indicate that for teams with low task interdependencies, project commitment (at Time 1 and Time 2) becomes a significant predictor of overall team performance, while the "interaction variables" interteam coordination and teamwork quality do not show significant influences. It appears that in teams with less task interdependency, the motivational aspects of the team members' commitment to the project's objectives become important, while the quality of interactions within and between teams is less influential as fewer technical interfaces with other teams mean less task uncertainty and complexity. Given the ultimate schedule interdependencies among all teams in the project (i.e., the project is not finished until all teams have completed their contributions), however, project commitment becomes an important variable in ensuring that the low task interdependency teams perform at expected levels to stay on target for the overall project.

Hypothesis 3 proposed a positive influence of teamwork quality on team performance. The results of this study are partly consistent with previous research (Hoegl and Gemuenden 2001, Sethi and Nicholson 2001), showing that teamwork quality at Time 1 is positively related to overall performance at Time 3. This relationship with overall performance is mirrored for schedule performance, while quality and budget performance are not significantly influenced.

Regarding Hypothesis 4b, it is important to note that teamwork quality at Time 2 (design phase of the project) shows much reduced correlations with overall performance and schedule performance, indicating that teamwork quality is more critical in the early stages of the project rather than in later phases. This result may illustrate that the uncertainties and complexities of the early concept phase require better teamwork, while later phases call for less interaction as task complexities and uncertainties are reduced. This explanation draws essentially on the notion of task properties as moderators for the teamwork-performance relationship. So far, empirical support for this moderated relationship comes from research investigating the interface between R&D, manufacturing, and marketing in new product development processes (Adler 1995, Olson et al. 1995). These studies demonstrate that the use of cross-functional teams (rather than using hierarchical planning and controlling, individual liaisons, or matrix structures) as an integrating mechanism is positively related to development performance only in cases of high product innovativeness (i.e., novelty of the product to the firm). Our research points out that there are differences in terms of complexity and uncertainty within one project. As team members work to analyze the project task at hand, gather and process information, plan work strategies and processes, task complexities and uncertainties are being reduced. Therefore, less collaborative work processes might be required. As the results of this study indicate, it was the high-quality teamwork in the early phase of this project (Time 1) that had a substantial positive effect on team performance in the final stage of the project (Time 3). The level of teamwork performed in the middle stages (Time 2) had little effect, neither positive nor negative, on team performance in the final stage of the project (Time 3). Provided that an interactive work process takes time and resources, these findings suggest that team members should consciously choose the collaborativeness of their work process and deliberately move from a highly interactive, creative work style (high teamwork quality) in the early concept stages of an innovative project to a work mode characterized by simultaneous task activities with team members carrying out concepts and plans crafted earlier.

This rationale for the influence of task properties on the teamwork quality team performance relationship seems also manifested in the exploratory regression analyses on the low and high task interdependency teams. Teams that have a high number of technical interfaces with other teams also encounter a high degree of uncertainty and complexity, as they rely on the parallel developments in a number of other teams with potential effects for their own work. To deal with these task uncertainties and complexities, teams need to quickly process information and adjust work strategies and so on, i.e., perform high levels of teamwork. From this perspective, high task interdependencies in multiteam projects require high levels of collaboration between and within the affected teams.

It is very interesting that, contrary to Hoegl and Gemuenden's (2001) findings in their study of software development teams, this research shows no significant influence of teamwork quality on adherence to budget or module quality. Furthermore, interteam coordination and project commitment do not seem to influence quality and budget performance nearly as much as they influence schedule and overall performance. While schedule performance was of utmost importance to this project (like is the case for many other new product development projects), module quality and development budget on the team level must be more driven by factors other than the process variables studied here. Interteam coordination, project commitment, and teamwork quality describe the quality of taskrelated interactions within and between teams as well as team members' focus on overall project objectives. As such, these variables do not attempt to capture the correctness of work strategies and task activities employed by team members. The three variables studied here do not address whether team members have done the right thing at the right time the right way. Thus, it cannot be expected that these variables account for all of the variance in all dimensions of team performance. Factors such as team members' technical and creative skills, as well as stability and predictability of the task environment (e.g., absence of frequent and substantial changes in qualitative demands from related modules) seem likely determinants of a team's quality and budget performance in a multiteam environment. While having both "customers" and "suppliers" that may create somewhat turbulent task environments, singleteam projects are more self-determined and have, therefore, higher control over issues affecting both quality and budget performance. It is somewhat striking that teamwork quality is not far stronger correlated with team performance than interteam coordination. This underlines the notion that teams in multiteam projects largely depend on other teams for achieving their own goals. Thus, the differing results regarding quality and budget clearly warrant further investigation, and the peculiar nature of multiteam projects may provide possible explanations.

Hypotheses 5a and 5b proposed positive relationships between teamwork quality and the team externally focused variables of interteam coordination and project commitment. The results of this study indicate strong support for the proposed positive relationships. One explanation for this is that the investigated teams do not compete with one another. Instead, they are highly interdependent and are required to cooperate to complete their work efficiently and effectively. Using Tjosvold's (1988) terminology, the teams perceived a cooperative rather than competitive goal interdependence. The findings are also consistent with Labianca et al. (1998, p. 64) demonstrating that "decreasing perceptions of inter-group conflict may rest upon improving intra-group relationships and, in turn, increasing in-group cohesiveness may decrease perceptions of inter-group conflict." Hence, a positive attitude toward collaboration within teams may transcend to the interteam level and vice versa (Williams 2001). Lastly, Hypothesis 5c proposed a positive association between project commitment and interteam coordination. Our results support this hypothesis, thereby confirming prior contributions arguing for positive relationships between these variables (Tjosvold 1988, Ashforth and Mael 1989, Sethi 2000b, Williams 2001).

Managerial Implications

Overall, the results of this study have high practical relevance based on the demonstrated predictive qualities of the process variables investigated. As our findings document, collaboration both within teams and between teams in the early project phases have a profound impact on later performance. Thus, assessing and managing such variables as interteam coordination, project commitment, and teamwork quality early on in the project helps identify and counteract problems long before financial and project-controlling instruments detect them. To give an indication of the practical relevance of the three process variables, we have averaged the three (correlated) process measures (interteam coordination, project commitment, teamwork quality) at Time 1, sorted the data set by this "overall collaboration" variable, and calculated the means of the top five and bottom five teams. This overall collaboration variable has a mean value of 3.00 for the bottom 5 teams and 4.00 for the top 5 teams. Correspondingly, the top 5 teams are 1.8 weeks behind schedule at Time 3, while the bottom 5 teams are 10.4 weeks behind schedule at Time 3. Thus, the difference is 8.6 weeks behind schedule at Time 3, with most significant additional costs (i.e., direct project costs as well as lost market opportunity) for every extra week of project duration.

With this in mind, this study offers several managerial implications. First, interteam coordination, project commitment, and teamwork quality are important determinants of team performance and, thus, important in ensuring the overall success of multiteam projects. They must be actively managed throughout the project. Furthermore, as is the case with teamwork quality, it may be beneficial, if not necessary, to adjust the collaborative nature of a team's work process in accordance with varying (i.e., decreasing) levels of task complexity and uncertainty. This pertains both to the stage in the project (early versus late) as well as the level of technical interdependencies with other teams, as these factors are likely linked to the task uncertainties and complexities with which teams have to deal.

There are a number of ways in which organizations can improve collaboration within and between teams. In addition to specific collaboration training (emphasizing, e.g., communication skills) before the start of a project, it is important to regularly monitor interteam and intrateam collaboration processes. For instance, one of the most collaborative and successful teams in our study held regular workshops where questions such as "What would we improve in our team and in the cooperation with other teams if this project started right now?" were openly discussed. To develop interteam coordination, overlapping team memberships can be useful. If some of the project participants belong to two or more teams, they are likely to further information exchanges between these teams and to create a network structure. Project commitment can be furthered by the project managers continually emphasizing the overall project objectives to the project participants, explaining how subprojects and individual teams tie into these goals, and providing feedback on progress toward project goal achievement (Blake et al. 1964, Bartunek et al. 1996).

Given the positive association of collaboration within and between teams, team-building interventions are likely to be beneficial to interteam coordination and project commitment and, conversely, interventions on the interteam or project level are likely to further within-team collaboration.

Lastly, considering the importance of collaborative processes to the ultimate success of multiteam projects, organizations need to emphasize collaborative skills in human resource planning and development. While recruiting and training programs in many technical organizations (such as R&D units) are strongly focused on technical knowledge and abilities, social skills are also necessary to ensure that the technical experts can work effectively and efficiently in highly collaborative environments such as multiteam product development projects.

Contributions, Limitations, and Outlook

This study employed a longitudinal multi-informant research design on a large-scale development project in the European automotive industry. The longitudinal nature of the study allowed for temporal spacing of cause and effect, providing us with a clearer understanding of causality. In addition, we drew on different informants for measuring the process variables (interteam coordination, project commitment, teamwork quality) and team performance, thus, avoiding possible common source bias. The statistically significant results found may, therefore, be regarded as particularly noteworthy, considering that interteam coordination, project commitment, and teamwork quality as evaluated by team members in the concept phase of the project show a substantial correlation with overall team performance, as evaluated by project managers approximately 24 months later in the project's final phase. We believe that the design of this study adds to team and innovation research as it provides longitudinal empirical evidence often called for in the literature (Campion et al. 1993, Gerwin and Moffat 1997, Stewart and Barrick 2000, Hoegl and Gemuenden 2001, Marks et al. 2001). Contributing to the understanding of inter-group relationships, this study shows that in team-based organizations such as multiteam projects, team-internal and team-external processes are not mutually exclusive. In a context where teams share a superordinate goal, teams will most likely succeed if they achieve high levels of cooperation both within the team and with other teams early in the project. This effect is particularly pronounced for teams with high levels of task interdependency with other teams.

One downside of a longitudinal multi-informant interview study such as this one is that the resource demands involved with handling the complexity and quantity of data collection often permit only a limited team-level sample to be included. A small sample, in turn, narrows the options for data analysis. In this regard, it should be noted that, given the limited team-level N in this study, statistical power was relatively low ranging from 0.20 to 0.49 for rejected hypotheses. Hence, while our research provides support for a number of our hypotheses with statistically significant results, this study does not provide the statistical power to firmly dismiss the hypotheses that were not supported by statistically significant results. Also, the data for our analysis were collected in one organization of the European automotive industry. This restricts the immediate generalizability of our findings by geographic region and industry. Hence, we strongly encourage further research in this area to assess whether our findings replicate in other organizational and task contexts (e.g., software development) and other geographical areas such as North America or Asia. In this regard, intriguing research questions arise from some of the more surprising findings of this study, such as the negative impact of interteam coordination on budget performance, or the weak or missing influence of all three process variables on module quality. Furthermore, in this paper, we have argued for mutually reinforcing relationships between the three process variables (interteam coordination, project commitment, and teamwork quality), and the positive correlations found support this notion. We encourage further research to take on a "temporal lens" (Ancona et al. 2001) and to more closely examine the three process variables over time to identify possible cyclical causal patterns between these variables and possible feedback loops from performance perceptions to the processes (Gersick 1988).

Appendix. Questionnaire Items

Variable	Items
Teamwork quality	*Communication*: There was frequent communication within our team. There was intensive communication within our team. Team members openly shared project relevant information. The team members were happy with the timeliness in which they received information from other team members. The team members were happy with the accuracy of the information received from other team members. *Coordination*: The work done on subtasks was closely harmonized. Our team avoided duplication of effort. Connected subtasks were well coordinated in our team. *Mutual Support*: Discussions and controversies were conducted constructively. Suggestions and contributions of team members were respected. Suggestions and contributions of team members were discussed and further developed. There was a cooperative work atmosphere in our team. *Effort*: Every team member felt fully responsible for the common team goals. Every team member fully pushed the project. Every team member gave the project highest priority. *Balance of Member Contributions*: All team members were equally engaged to achieve the common goals. All team members were fully contributing to our team. The team members complemented one another as best they could. *Cohesion*: There was personal attraction between the members of our team. Our team was sticking together.
Interteam coordination	Connected processes and activities were well coordinated with other teams. Duplicated and overlapping activities were avoided. We had no problems in coordinating with other teams. Conflicts with other teams were settled quickly. Discussions with other teams were conducted constructively.
Project commitment	Our team feels fully responsible for achieving the common project goals. This project has the strong commitment of our team members. The team members are proud to be part of the project. The team members are committed not only to their teams, but to the overall project. Our team values to be part of this project.
Overall performance	Going by the current status, this team can be regarded as successful. So far, all team goals have been achieved. The team's output so far is of high quality. The team is satisfied with its performance to this point. The project leadership can be fully satisfied with the task progress of this team.
Quality	The prototype parts are as expected regarding: (1) dimensional integrity, (2) durability, (3) functionality, (4) manufacturability, (5) optical attractiveness, and (6) tactile attractiveness. The test results (laboratory tests, field tests, crash tests, and so on) are fully compliant with the specifications for the parts.
Adherence to budget	The team incurred unplanned extra cost.^{R} The costs of the team developed much higher than expected regarding^R: (1) development costs, and (2) prototype costs.
Adherence to schedule	According to the team's task progress, project deadlines should be adjusted outward by…weeks (negative value for ahead of schedule performance).^{R}

Note. These items are translations of the items used.
^{R} = reverse coded item.

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