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A Knowledge Based View of the Team

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Drawing on the works of Conner and Prahalad (1996), we advance their knowledge based view of the firm and developed the knowledge based view of the team. The central tenet of our knowledge based view is that the existence and effective performance of the team is hinged on the reciprocal knowledge substitution among team members. The core team process of reciprocal knowledge substitution mediates the relationship between knowledge heterogeneity in team composition and team performance. In particular, we posit that heterogeneous teams (in terms of knowledge composition) outperform homogenous teams only if positive substitution (the superior replacing the inferior) is in operation. Further, we reason that the reciprocal substitution process is modulated by the original (vertical) knowledge substitution in the firm structure. In essence, we expand the established market ↔ firm spectrum to market ↔ firm ↔ team, which exhibits (from market to team) the decreasing effect of transaction costs and the increasing effect of learning (knowledge substitution). In addition, we extrapolate our knowledge based view to the case of interfirm teaming (partnerships and alliances).

Keywords: knowledge based view, team, vertical and reciprocal knowledge substitution

Introduction

Nowadays, teams are springing up wherever one looks inside a modern organization. Many believe that a majority of current teamwork initiatives (GE's Work Out and Self Managed Work Teams - SMWT) were developed from the early practice of quality circle (QC) in the TQM movement (Gibson & Tesone, 2001; Wachtman, 1995). Indeed, the pivotal role played by this timeless management practice has been well discussed and advocated in the literature both academic and practical (Fullerton, 2001; Sakakibara, et al., 1997; Stanley, 2004). It is believed that virtually all TQM firms adopt team organizations in their implementation (Thompson, 1998). As an exemplary implementer, Texas Instruments Malaysia (TIA), a wholly owned subsidiary of Texas Instruments, has evolved from a traditional hierarchical management structure to a team based organization (TBO) over two decades (Cheney, et al., 1994). The 1992 Boston Group survey reports that US participating firms rated "inter-functional work teams" the most successful action program in TQM implementation (Adam, et al., 2001). A similar survey found that nearly 90% of service firms use short-term problem solving teams (Hackman & Wageman, 1995). Not surprisingly, Jassawalla and Sashittal (1999) bemoaned that the bourgeoning popularity of teams has paled our understanding of why and how the structure works.

Since most teams are hosted within a firm, it is plausible for us to apply theories of the firm to shed light on the team. Kogut and Zander (1996) defines firms as "… social communities in which individual and social expertise is transformed into economically useful products and services" (p. 503). Other scholars have offered similar perspectives. Tsoukas (1996) interpret the firm as a distributed knowledge system. Mitroff and Linstone (1993) suggested that corporations could be viewed 'as systems for the production and testing of ideas' (p. 4). Drawing on their work, we conceptualize teams as inquiring systems that are designed to generate knowledge about the production process in which team members are involved.

Salas, Dickerson and Tannenbaum (1992) defined a team as "a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal / objective / mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span of membership" (Mathieu, et al., 2000, p.4). There is a similarity between the two organizational structures: both the firm and the team deal with the joint utilization of dispersed knowledge. As such, we believe that our theorizing efforts on the team will contribute to the explication of the existence of the team and the prediction of team performance.

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The Resource-Based Theory of the Firm

Instead of viewing the firm as a mechanism designed to avoid market failures caused by opportunistic behaviors, Conner & Prahalad (1996) develop their knowledge-based view of the firm, which envisages the firm as a generator of positive value (knowledge). The main thesis of their theory is that organizational modes - market vs. hierarchy - determine how knowledge is applied to production activities. In this section, we shall elaborate on the above thesis and the associated knowledge substitution and flexibility effects, as well as their implications for productivity.

To aid introduction of the firm theory, we consider a hypothesized simplest firm with only two members: X as the only employee and Z as the sole employer. As an employer, Z has the authority to direct the behaviors of X based on the agreed employment contract and thus substitute his knowledge for the knowledge of X. Alternatively, instead of entering into employment relationship (firm organization), Z can get the business done by negotiating a market contract (make payments for certain amount of needed output from X) without altering the way X conducts his own business activities. We term the two polar cases of organizational mode as firm (hierarchy) and market contracting respectively. The two organizational modes primarily differ from each other based on the existence of authority / autonomy (the rights to apply knowledge to production activities).

Next, we look at the aggregate productivity of X and Z organized in the firm and the market form. Let's use P_M and P_F to represent the aggregate productivity of X and Z in the two modes respectively. As shown in Figure 1, the difference (ΔP) between P_M and P_F is the extra rents earned by the adoption of the firm mode. If the productivity difference across modes is positive ($\Delta P > 0$), the firm mode prevails. Otherwise, the market-contracting mode prevails.

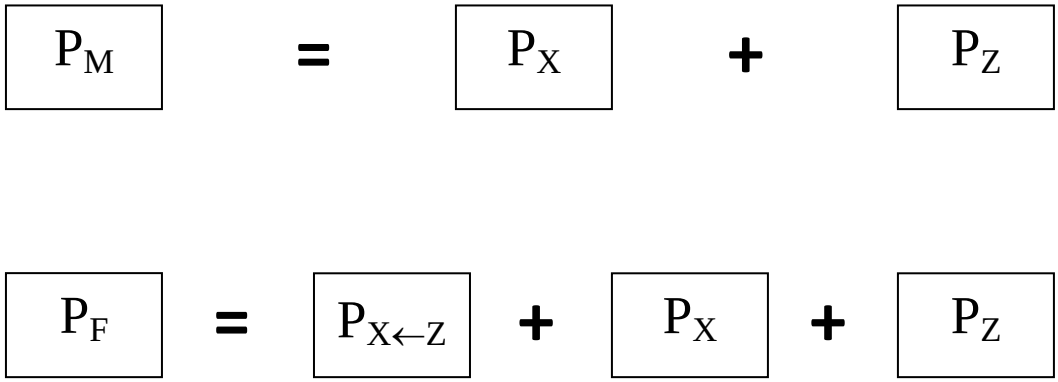

Figure 1. Productivity comparison between the market and firm mode - adapted from Conner and Prahalad (1996).

X and Z's choice of the firm mode over the market contracting mode entails two effects that affect the productivity differences (ΔP) between the two modes: the knowledge substitution effect and the flexibility effect. The knowledge substitution effect concerns how the knowledge currently possessed by X and Z is applied to the production processes they are engaged in. Obviously in the firm mode, it is easy to achieve the joint productivity of X and Z under market contracting by simply allowing X to conduct his activities on his own without Z's direction. In the firm mode, X also has access to Z's knowledge in addition to his own. However, X is subject to Z's authority to substitute X's knowledge with Z's. As such, whether the knowledge substitution positively contribute to ΔP is dependent on the extent to which Z's knowledge is different from and superior to X's knowledge. If they have identical sets of knowledge of equivalent quality, then the extra rents generated by knowledge substitution are negligible. On the other hand, possession of completely different sets of knowledge induces low knowledge absorption, which is counterproductive to X's internalization of Z's insights and understandings. This brings up the second effect associated with the firm mode – flexibility.

The flexibility effect concerns how the relative cost of altering X's duties and responsibilities differs under the two organizational modes. Under market contracting, Z has to enter into a renegotiation process with X to determine the new contract terms for X' s new duties (how to define, count and pay for X' outputs). In the firm mode, this renegotiation

process, which might be lengthy and expensive, is not necessary due to Z's authority over knowledge application. The magnitude of the flexibility effect is dependent on both the environmental complexity and Z's intelligent capacity. If business activities are conducted in a relatively static environment, there is little need for Z to adjust X's duties and responsibilities. In a relatively turbulent and dynamic environment, the cost difference can be significant if Z must frequently respond to uncertain and unplanned events (by adjusting X's duties and responsibilities) generated by the environment. The benefit and cost of ongoing knowledge substitution jointly determines the mode of organization Z and X adopt. In situation of higher productivity gain and higher renegotiation (to substitute) cost firm mode is advantageous to market. In the situation of little productivity gain and lower renegotiation (to substitute) cost market mode dominates. The other two combinations indicate no clear direction of superiority. Either market or hierarchy can be selected.

Of course, this simplest structure - 1 on 1 hierarchy - is rarely the case for modern organizations, like TIM. At its inception in 1972, TIM was established as a "traditional functional/vertical hierarchy" (Cheney & Sims, 1994). The specialized and departmentalized structure remained untouched for 15 year with 60:1 as the ratio of operators/supervisors. The 79 supervisory positions are no doubt designed to assume the role of knowledge substitution-monitoring and directing the production activities of the thousands of manufacturing staff. In praising the persistence and continued spread of the organizational mode of hierarchy, Jacques (1990) claims that the bureaucracy (hierarchy) is the only organizational form that allow an organization to employ large numbers of people and coordinate the divided and specialized activities with ambiguous accountability for each member.

The (classical) organizational theory has long conceptualized the organization as an information "processor" and problem "solver" with the aim of achieving maximum rationality and efficiency (Nonaka, 1994). This goal could be best achieved with the application of rational administrative procedures (Miller, 1996). By engaging in analytical and synthetic learning, the executives at the top of the hierarchy articulate grand strategic plans in responding to environmental stimuli. The strategic plans are then instilled into the minds of middle managers, who devote themselves to experiential and interactive learning in efforts to develop detailed routines and programs to realize the corporate goals. Through structural learning and institutional learning, lower level employees are trained to perform those imposed tasks and routines and conditioned to obtain coherence among their beliefs (Miller, 1996). The scalar substitution chains run from the strategic apex through middle layer and down to the operating core of the organization. They resemble the lines of command running from the top chief executives, through successive layers of managers and supervisors, and down to the operators. This resemblance is self-justified due to the stated requisite for knowledge substitution – authority.

The hierarchical information processing paradigm has long been criticized for its passive and static view of the dynamic organization without due consideration of knowledge creation (Nonaka, 1994). In the case of TIM, the traditional /vertical hierarchy was largely blamed for employees' attitudes of "protectionist" and actions of "cover your rear" before they began their TQM journey in 1980 (Cheney, et al., 1994). Because of the close coupling of authority and knowledge substitution, we term the knowledge substitution down the hierarchy as vertical substitution. As we shall explain in the next session, the team structure embedded in a traditional pyramidal structure decouples the association and provides "a field" for producing knowledge. In this regard, Reich (1987) glorified teams as "heroes" in the corporate renaissance.

A Knowledge-Based Corollary of the Team

In this section, we shall extend the knowledge-based theory of the firm to the team following the same line of reasoning. Because we will repeatedly refer to the concept of team, we feel necessary to define it and distinguish it from group at the outset of our exposition. A team is a collection of interdependent and differentiated individuals who share responsibility for specific outcomes for their organizations (Landy & Conte, 2004). Groups are simply collections of individuals with varied degrees of division of responsibility. While all teams are groups, the converse is not always true. Therefore, the relationship between teams and groups can be thought as subset to superset and the special to general.

We again begin with another hypothetical firm with only three members: X, Y as employees and Z as employer. Cooperation theory (Johnson and Johnson, 1989) submit that social interaction takes on three modes: cooperation, competition, and independence. Mapping the three modes of social interaction into our firm context results in two modes of interaction between X and Y: team mode and independence mode. In team mode, X and Y cooperate and pursue the best common interest. In the independence mode, X and Y don't interact directly

and only perform solely according to Z's instructions and pursue their own best-allowed rewards. We next discuss the firm productivity differences across the two interaction modes within a firm.

$$P_I = P_{Y\leftarrow Z} + P_{X\leftarrow Z} + P_X + P_Z$$

$$P_T = P_{Y\leftrightarrow X} + P_{Y\leftarrow Z} + P_{X\leftarrow Z} + P_X + P_Z$$

Figure 2. Productivity comparison between the team and independence mode.

Reciprocal Knowledge Substitution

The vertical substitutions still persist and work exactly in the same way as in the previous firm situation. The vertical substitutions reflect the one-way traffic of knowledge from Z (employer) to X or Y (employee). We denote the two possible vertical substitutions as Z→X, and Z→Y. The effects of Z→X and Z→Y on productivity are pictured in Figure 2 as $P_{X\leftarrow Z}$ and $P_{Y\leftarrow Z}$ respectively. $P_{X\leftarrow Z}$ and $P_{Y\leftarrow Z}$ (in the calculation of P_I) are the only two productivity differences resulted from (vertical) knowledge substitutions so long as X and Y opt to stay independent of each other.

X and Y' selection of team mode over independence mode, however, complicates the situation and gives rise to a new kind of knowledge substitution - reciprocal substitution between X and Y, denoted as X↔Y. Its impact on productivity is depicted by $P_{Y\leftrightarrow X}$ in Figure 2 (in the calculation of P_T). The reciprocal substitution differs from vertical substitution not only in the bilateral direction of knowledge flow, but also in the disassociation of knowledge application from authority possession. This disassociation signifies the importance of communication and mutual understanding between team members, because neither X nor Y has the power to dictate the other. This overtly simple theoretical separation, in real world, might not be appealing to every member of the team, especially those who previously assume supervisory responsibilities. TIM encountered such difficulties along its path of transformation. One self-centered manager dominated his team and refused to share his authority in making decisions. Unsuccessful in adapting to the "give-and-take" spirit of team, he eventually had to leave TIM (Cheney & Sims, 1994). The individual dominance is often cited as the cause of "groupthink" syndrome, in which group makes flawed decision with disastrous consequences.

In team mode, the knowledge that best serves common interests is applied to business activities. It can belong to either one of X and Y in its entirety or to both partially. In forming a team, X and Y agree to enrich common intellectual assets to improve productivity. This reciprocal substitution is echoed in Shaw (1976)'s description of teams as " two or more persons who are interacting with one another in such a manner that each person influences and is influenced by each other person" (p.8). Further, a special group level phenomenon – team mental model (TMM) - ensues X and Y's formation of a team. The construct of TMM refers to what team members know about other teammates' knowledge assets and what they share in common (Edwards, et al., 2006; Klimoski & Mohammed, 1994; Mohammed, et al., 2000). In literature, it has also been referred to as common cause maps, shared frames, teamwork schema, etc. In essence, TMM is a knowledge structure (mental template) emerged at the group level, which is imposed on the team's information environment by the owner – the firm. The TMM not only orders the team's information environment, but also subsequently enables team interpretation and action. The development and existence of such TMMs are largely dependent on team composition, and is posited to foster optimization of various team processes. The optimized team process in turn leads to superior team performance (see Figure 1 on p429 proposed by Klimoski & Mohammed, 1994). We speculate that reciprocal knowledge substitution mediates the

relationship between team composition and team mental model / team processes (Mathieu, et al., 2007). The effectiveness of the reciprocal knowledge substitution is affected by the knowledge structure of the team of X and Y (team composition) and the extent to which Z decide to exercise his unilateral substitution on X and Y (performance context). Consider the extreme case in which Z enforces 100% strict unilateral substitution on X and Y with the same set of knowledge, X has now the identical set of knowledge as Y does. The perfect overlapping will diminish the effect of circular substitution on productivity to zero. However, if Z allow X and Y to retain their differentiated sets of knowledge (either by experiential endowments or training), the effect of the proposed circular substitution could become potentially significant as X and Y "pollinate" each other during work. Based on the results of their study, Stasser and Titus (1985) concluded that diverse groups composed of members with different information by virtue of variation in their backgrounds, training, or experiences are more likely to share their unshared information than homogenous groups. This might underpin the formation of cross-functional team (CFT) and quality circles popular in TQM literature. Although each member may come from a different department or functional area with different training (employer's unilateral substitution with tailored knowledge), the team can combine different perspectives and transform them into effective solution to the situations they face. Pelled, Eisenhardt and Xin (1999), based on the analysis of a sample of 45 teams, found that task conflict driven by functional diversity had a positive association with cognitive task performance. Further, they insinuate that the conflict with functional diversity as antecedent "fosters a deeper understanding of task issues and an exchange of information that facilities problem solving, decision making, and the generation of ideas" (pp.22-34). Jackson, May and Whitney (1995) also suggest that heterogeneous groups were more innovative and creative than homogenous groups in their empirical study. Nonaka (1994), on the other hand, emphasized the importance of information redundancy (knowledge overlapping) in facilitating transfer of tacit knowledge and team cohesion in the innovation process in Japanese organizations. Therefore, a critical issue in managing reciprocal knowledge substitution is maintaining both heterogeneity and homogeneity in equilibrium.

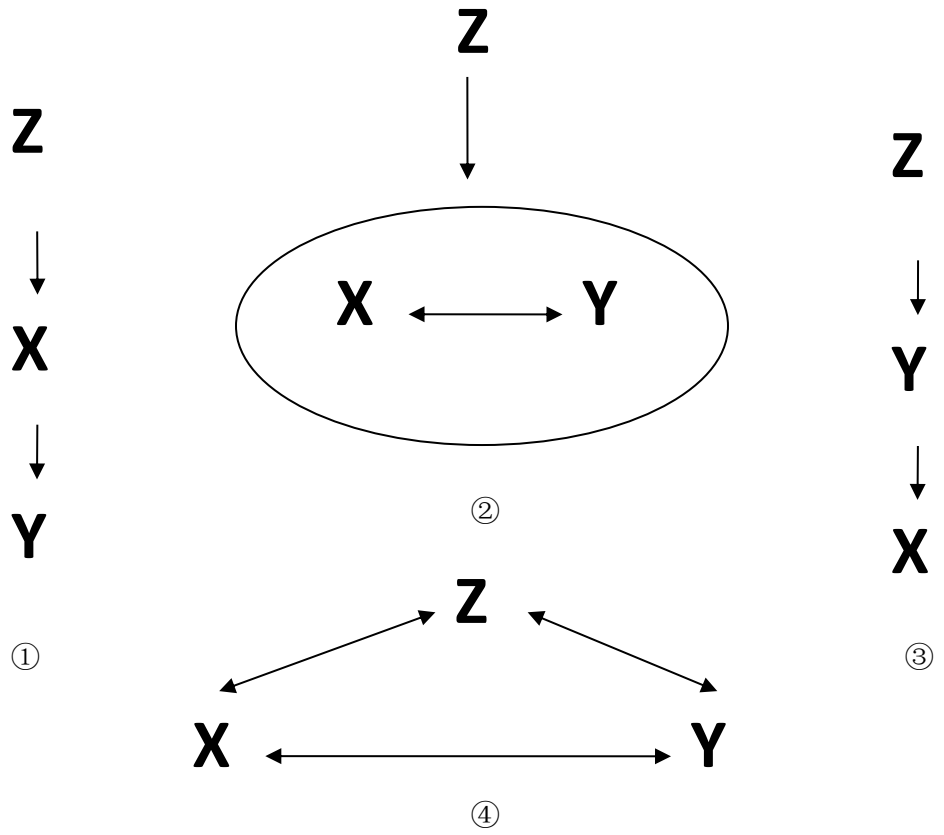

Figure 3. The flexibility of teaming①

The Flexibility Effect

The teaming between employee X and Y also implies new ways that the employer Z can alter duties of the two employees. As illustrated in Figure 3 (the case of ②), instead of making changes to the duty of X and Y directly and separately. Z can simply redefine the goals and performance measures for the whole team, and then have the team manage corresponding duties changes of its members. In addition, Z can also erect sub-hierarchy within the firm, which means he can appoint X (or Y) as a middle layer of management who decides how Y (or X) should do his job. When the hierarchy of Z→X (or Y) is vertically stacked on top of X→Y (or Y→X), a pure chain structure emerges, resembling the chain of command in a modern organization (① and ③ in Figure 3). Ultimately, Z can give up its "dictatorship" and team up with X and Y, forming a pure flat structure composed of three two member teams (X↔Y, Z↔X, and Z↔Y in ④ in Figure 3).

This flexibility effect (② in Figure 3) is best reflected in GE's WorkOut program. A typical WorkOut session begins with a talk by CEO Jack Welch, who roughs out a problem agenda for a group of 40-100 GE professionals. The large group is then broken into small action learning sets to tackle various parts of the agenda for the next two days. On the final day, the GE executive returns and evaluates the proposed solutions presented by teams (Ulrich, et al., 2002). Essentially, a market transaction like relationship is reestablished within a hierarchy between Z (Jack Welch) and X, and Y (team members of the WorkOut) within the firm environment. X and Y retain their authorities in applying knowledge in solving the given problem. However, their solution is subject to the appraisal and compensation offered by Z.

If we consider the case in a real world setting like TIM, where a company has 2000 employees, self-managed teams allows the employer efficiently organize the firm without hiring many middle level managers and complicating the management hierarchy. Benefiting from The above proposed flexibility, TIM was to increase the ratio of operators / supervisors from 60:1 to 200:1 and reduce supervisory positions from 79 to 18 (Cheney, et al., 1994).

Contributions and Implications

This essay on teaming contributes to our understanding of the team structure in three major ways. First, it explains in a fundamental way why various team structures exist. Second, it provides an alternative view on the way team knowledge structures influence team performance. Finally, it enriches our understanding of the impact of organizational environment on team performance.

Despite the widely held belief that the whole is greater than the sum of individual endeavors, the existence of teams has rarely been theoretically justified in light of organizational learning. One of the central purposes of this essay is to fill in this theoretical gap and to evoke further research interest in studying teamwork with regard to knowledge creation and organizational learning. Our perspective on the existence of team structures within a "transaction free zone" (a firm structure in Baldwin, 2008) is that teams are created to better utilize and integrate the distributed stores of knowledge owned by individual members (Kellermanns, et al., 2008). Because the team separates authority from the evaluation and application of knowledge, team members appreciate knowledge solely based on merits rather than ownership and power. In this essay, we distinguish between vertical unilateral knowledge substitution (in the knowledge based theory of the firm) and the team enabled horizontal lateral knowledge substitution. The latter overcomes two major shortcomings of the former – storing knowledge vertically in isolated "silos" and "watering" knowledge from the top down to the bottom. While vertical knowledge substitution requires explicitly specified bureaucratic structures and procedures, horizontal knowledge substitutions inside a team can be accomplished dynamically via implicit coordination mechanisms (Rico, et al., 2008). Commenting on Japanese quality circles, Dale (p. 104, 1994) stated "in general, QCs are employed for reasons of education, communication, improving environment and changing attitudes, etc., and not to reduce costs".

Although teams are being employed in organizations with increasing frequency, the factors and conditions leading to team success are not well comprehended (Carley, 1997). Over the years, an abundance of research has been carried out to examine the various factors that contribute to high team performance (Brannick, et al., 1997; Mathieu & Schulze, 2006; Salas, et al., 1992). In general, these models of teaming follow an input-process-outcome (I-P-O) framework (Mathieu, et al., 2000). The IPO model posits that team processes (communication, explicit and implicit coordination, and coordinated use of resources) mediate the relationship between inputs (knowledge diversity, composition, knowledge structures - Team Mental Models) and outputs (performance-quality and quantity, team longevity, and members' affective reactions). Our proposed (reciprocal) intra-team knowledge substitution fits in the "team processes" part of the IPO framework.

However, our corollary departs from the IPO backed theorizing efforts on predicting team performance in that we deem that knowledge differences lead to reciprocal knowledge substitution among team members, which in turn affects output. Put it differently, the differentiated sets of knowledge possessed by individual team members induce constituents to initiate interpersonal processes to discover and formulate the best solution for the task at hand. Ideally, when inferior ideas are replaced by superior ones, team level performance (decision quality) will be enhanced. When superior ideas are dominated by inferior ones, the adverse knowledge substitution will cause deteriorating team performance. Our propositions are in agreement with the view held by Rico and colleagues that "teams are often designed to stimulate mutual learning among members, which accelerates changes in team knowledge" (Rico, et al., 2008, p.178). Admittedly, the knowledge based view contradicts the consensus in existent team cognition research, which suggests that the team performance benefits from shared cognition among team members (Cannon-Bowers & Salas, 2001). Notably, available empirical support for this "agreed upon truth" is somehow fragmented and ambiguous (Rico, et al., 2008). Cooke, Salas and Keikel (2004) attributes the inconsistent empirical findings to the often simplistic analyses of team knowledge. Conceptually, the term of shared cognition is neither simple nor unitary and has been adopted to mean too many different things. Cannon-Bowers and Salas has warned that "it may be on its way to being meaningless" (pp. 200-201, Cannon-Bowers & Salas 2001). Fortunately, recent research has uncovered a second dimension of shared cognition (TMM) in addition to sharedness. Accuracy of a TMM is defined as the closeness between a team's TMM and a referent set of high quality knowledge structures established by experts (Mathieu, et al., 2005). A high level of sharedness may not necessarily be indicative of a high level of accuracy. Accuracy of a TMM has its own effects on team processes and team effectiveness. Kellermanns et al. (2008) confirmed that mental model sharedness did not always improve team decision quality and might even negatively impact group decision making. Because accuracy is assessed between shared team knowledge structures to those established by experts, it can be potentially be used to evaluate longitudinally the outcome of our proposed knowledge substitution process. We anticipate that the combination of team shared cognition and team knowledge substitution might lead to some groundbreaking findings in the future.

Another distinct feature of our knowledge based corollary of the team is that we treat organizational context (Z in Figure 3) as an integral part of the intra-team interaction (X↔Y) process. First, the hosting firm, represented by Z, can change team fluidity (membership and knowledge composition) via tailored hiring, training and promoting practices. Second, Z can structurally alter (empowerment) how team members interact with each other by make the team either more hierarchical (vertically) or more flat (horizontally spreadout). By the authority vested in him, Z can also apply vertical knowledge substitution and ensure team members hold a compatible understanding of his strategy and expectation. Thus, we need to explore the role of organizational context (hosting environment) beyond a simplistic moderator or static classifier and recognize the coexistence of and interaction between intra-team and firm-team communications.

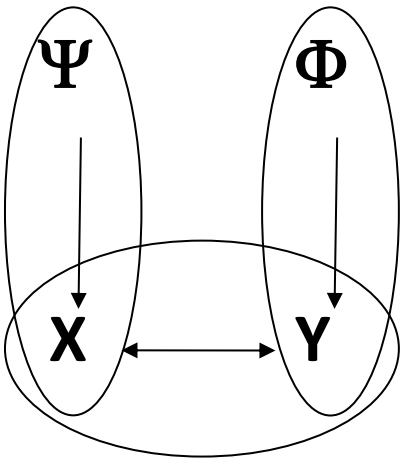

Figure 4. The structure of inter-firm teaming.

So far, we have restricted our discussion to teams embedded within a firm. It is worthy noting that our proposed core team process (reciprocal knowledge substitution) can be easily extrapolated to the case of interfirm teaming. The only change needs to be made is the addition of another employer and rearrangement of the unilateral vertical knowledge substitutions (see Figure 4). The team in Figure 4 is still the two man team (X and Y). However, they belong to different firms (employers Ψ andΦ). The intrateam knowledge substitution (X↔Y) is now subject to the influence of two vertical knowledge substitution processes (Ψ→X and Φ→Y). Another concern is that X and Y can no longer be assumed to share the same goal as in the previous single firm case. This raises an interesting question about whether the firm should serve as a necessary "container" for the team to exist and function. As shown in Figure 5, the rearrangement of the team structures in Figure 4 illuminates an intriguing path of a flat team structure's morphing into vertical hierarchies. After all, the authority enforced vertical knowledge substitution can be conceived as a special case of the reciprocal substitution, which is not necessarily driven by authority.

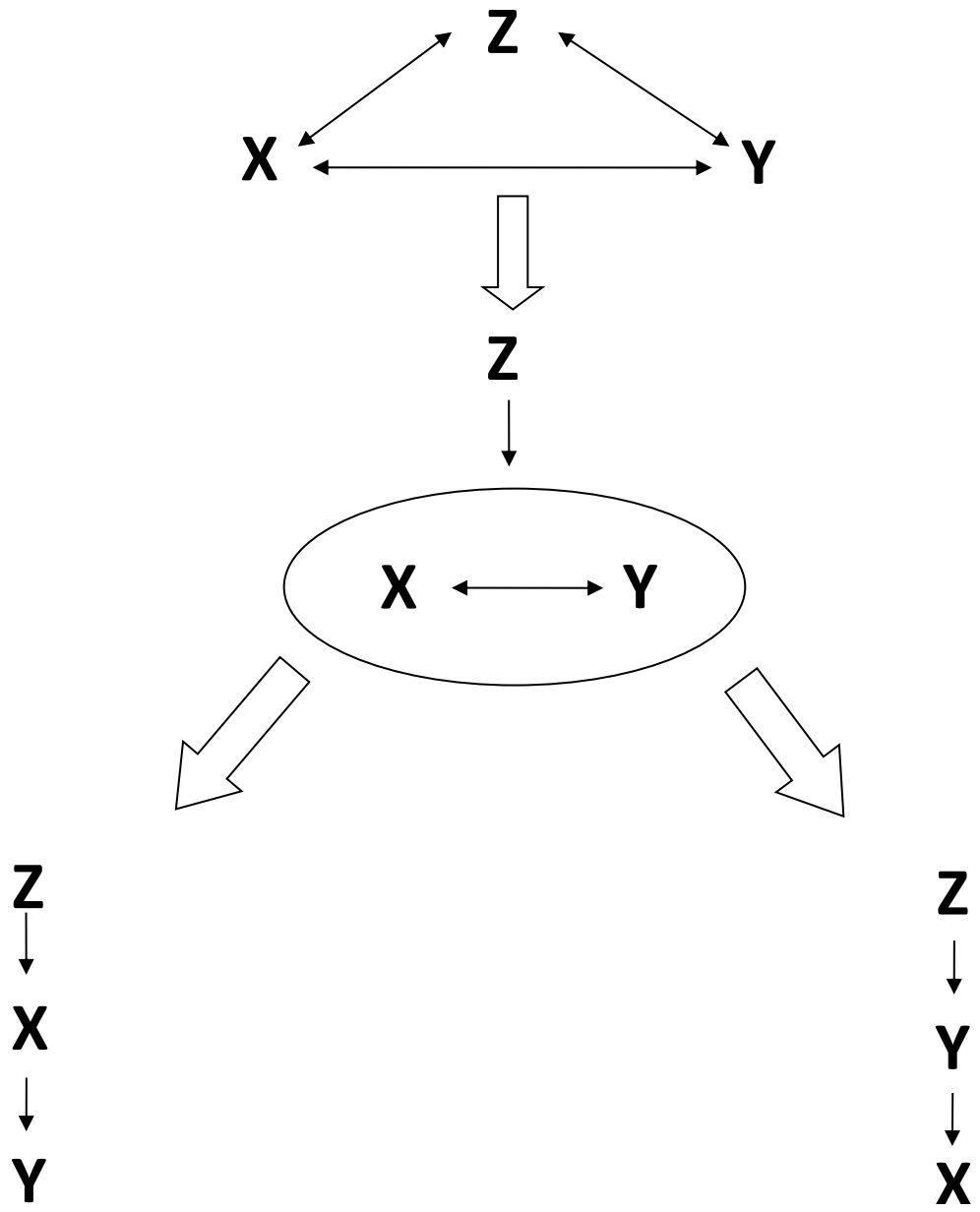

Figure 5. The structural transformation of the team into the firm.

Conclusions

The water-shedding Hawthorne studies conducted in 1920s incidentally discovered the importance of human relations to productivity and gave impetus to the study of teamwork. Application of teams (quality circles) expanded rapidly with the TQM movement in 1980s and several early adopters, including Motorola and Xerox, won the Malcolm Baldrige National Quality Awards. It is no doubt that knowledge is increasingly recognized as a critical resource for competitive advantage and that firms must explicitly manage their organizational learning. Both hierarchy and team are essential control mechanisms for modern organizations. Teams are the key learning mechanisms, generating and absorbing novel information, whereas the hierarchy is more effective in processing important information. The increasing complexity and turbulence of business environments urge organizations to "uncover new problems or develop solutions independent of current problems" (Lewis & Slack, 2003, p.392). Whereas the bureaucratic control mechanism seems inadequate at facilitating knowledge creation and collective learning, the team structure, unrestricted by authorities and functional boundaries, accommodate an organization's learning efforts. Therefore, an organization needs to view and employ both hierarchy and team as complementary mechanisms rather than a singular choice.

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