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A River Runs Between Us: Legitimate Roles and Enacted Practices in Cross-Functional Product Development Teams[i]

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Abstract

The use of cross functional teams involving marketing and engineering functions has become commonplace in industry as a means to effectively develop new products. The practices, and indeed best practices enacted by such teams will depend on team members' perceptions of their own role and the perceived roles of other team members. Individuals will tend to identify strongly with their archetypal disciplinary role. In this paper we propose specific reasons why this is so, and under what conditions individuals may take on more interdisciplinary roles. Specifically, we use institutional theory and organizational learning theory to posit that team members seek legitimacy by adopting and enacting archetypal functional roles, and that team members enact practices that conform to these roles; legitimate practices are selected via information and knowledge provided by external resources.

This theory-building exercise is driven by examination of six different new product development teams, consisting of University of Minnesota graduate students in business and engineering. Teams work with faculty from business and engineering and an industrial sponsor to develop a physical prototype and new product business plan over a period of nine months. Data concerning team member perceptions and actions were collected via survey and event history construction, and were used to generate focus and propositions contained herein.

Introduction

The mighty Mississippi River begins as a creek in northern Minnesota and winds its way down into the Gulf of Mexico. Historically the Mississippi River has been used as both a literal and metaphorical boundary between the East and West; societal claims are often qualified by the phrase "...best xxx west of the Mississippi...". As the Mississippi begins its long journey southward, it winds its way through the campus of the University of Minnesota, separating the campus into two halves, the East Bank and the West Bank. On the East Bank sits (among other things) the Institute of Technology, where engineering and science students and faculty reside; on the West Bank sits the Carlson School of Management, where business students and faculty take residence.

By the time the River cuts into campus it is perhaps 500 feet wide; the physical act of walking from one bank to the other across the unheated foot bridge, especially during the dead of a Minnesota winter, is a daunting challenge for anyone. Beyond the physical boundary however, the river is a metaphorical boundary that for all practical purposes might as well be 500 miles wide. Seldom do business and engineering faculty or students matriculate. Some engineering students take business school classes, but few business school students seek out engineering classes. In both cases institutional forces tend to limit a more interdisciplinary approach to education. The chasms run equally deep between faculty. While a few individual faculty may forge connections between the banks, institutionally there is little incentive to forge cross-functional relationships.

With the help of individual visionary faculty and management support, however, this script is beginning to change. Since 1991 the Institute of Technology and the Carlson

School of Management have jointly designed, managed, and staffed a professional master's degree in Management of Technology. More recently, faculty from the Department of Mechanical Engineering, the Department of Marketing, and the Department of Operations and Management Science have developed a graduate level course entitled "New Product Design and Development". The purpose of the course is to combine engineering and business students into cross-function product development teams, and through the aid of faculty instructors and an industry sponsor, develop a physical prototype and new product business plan over a period of nine months.

What happens when these students are thrown together? Do students tend to maintain a strong functional focus in their activities, or is there more equal sharing of tasks and roles? What type of (best) practices do these teams engage in, and why? From what sources do they learn about such best practices?

These are the questions we seek to answer in this paper. We use the experiences and perceptions of student team members to develop relevant propositions, and cite the body(ies) of theory that support such propositions. We then combine the propositions into a single model showing, in the end, how particular (best) practices are enacted by teams. We conclude with comments concerning how these results can be generalized to an industry setting, and how research concerning cross-functional product development teams in industry can aid in our understanding of these student teams.

Study of the student setting is unique and important--universities across the country are adopting similar programs and the need to understand how such teams function is acute. In general, however, the reader should find that even though our data and context involves students, that the concepts, model, and empirical data presented in the paper is realistically generalizable to new product development teams in industrial settings. This is especially true in the context of new product development teams where (a) team members have not worked together before, and (b) the team is functioning as a subcontractor, where the an OEM is the customer of the team's effort.

The specific academic course which provides the context for our research is "New Product Design and Development", a 3-quarter, graduate level course jointly offered by the Carlson School of Management (CSOM) and the Institute of Technology (IT). Teams of six to ten students (half second year MBA's, half graduate level engineers) along with faculty members from IT and CSOM and company representatives work together for the entire academic year (September to June) to develop a product concept for the sponsoring company. By June, each team is expected to deliver a working physical prototype of the product and an extensive business plan which indicates why, how and when the product should be marketed and promoted. As much as possible, all aspects of product design are addressed including concept design, detail design, manufacturing, marketing, introduction strategy, and profit forecasting. The projects are real in that the sponsoring companies expect results and intend to bring the new products to market.

In 1996-97 participating companies were:

- Donaldson Company, Inc.--filtration and acoustic products for mobile and stationary engines
- Aetrium--motion control products for the semiconductor test industry
- Spinal Designs--medical products for unloading the spine
- Horton, Inc.--mechanical clutches, brakes and web control products

• University of Minnesota Medical School--a project capitalizing on new technology developed at the University of Minnesota Medical School

• Augustine Medical, Inc.--medical products for thermal regulation of the body.

Finally, a note should be made about the format of this paper. Normally, a paper of this nature would set forth theoretical propositions, followed by presentation of data collection methods, results, and discussion. This format presumes an a priori theoretical model. Such was not the case--nor do we wish to create an impression of such--in the research presented here. The work here is presented as a theory building exercise (Glaser and Strauss, 1967). Open ended questionairres were used to generate data, and from this data theoretical propositions were developed. Therefore, the format of the paper will be to present our methods for obtaining grounded observations, and then intermingle our interpretation of the data with its theoretical meaning via review of appropriate literature.

Methods

The method of observation is two-fold: (a) survey questions, and (b) construction of an "event history file" via direct ethnographic observation. Surveys were administered during the beginning of the second (of three) quarters. Surveys were filled out by 6 CSOM and 13 IT students, or a total of 19 of the 33 possible students for a return rate of 57%. Questions were open-ended, which facilitated theory development rather than theory testing. Responses were aggregated using the affinity method (Asaka & Ozecki, 1990). Direct ethnographic observation and archived documents (e-mail messages, team meeting minutes) were used to construct event history files for each team. The event history file methodology (e.g. Van de Ven & Polley, 1992) develops an exact historical account of a process as it unfolds over time. Each "event" is then codified according to the constructs of the theory being formulated and/or tested. Here, events were coded as to what type of "best practice" was being implemented (if any). The list of specific best practices considered will be discussed later.

Role Expectations of Self and Other Team Members

Students were given a survey with many open-ended questions. Amongst the questions, students were asked: "What is the role of engineering in new product development? What is the role of marketing in new product development?" Responses were collected and aggregated into the following categories using the affinity method (Asaka and Ozeki, 1990). The affinity method is a process by which like-ideas are put together into meaningful categories. Such aggregation is useful for studying the quantitative nature of qualitative data. The student responses aggregated into the following categories:

(1) market and customer focus: understand customer needs, understand market issues, gather feedback from users

(2) strategic fit: determine fit between product concept and company's technology strategy, determine fit between product concept and company's business strategy

(3) resources and support: seek management support, request resources

(4) teamwork and communication: be creative, integrate across functions, support the team, support diverse thinking, communicate, have an open mind, be persistent

(5) development process: set goals, plan, coordinate, select the right project, define the project, determine ease of manufacturability

Tables 1 and 2 show the subsequent responses.

--place Table 1 & 2 here--

Neither group of students believe that their own role or other team members' roles should primarily focus on strategic fit (they rely on the industrial sponsor for such information and decision making) or resources and support (they rely on course instructors to provide such, and probably take it as a given). There is consistent opinion that all team members should contribute to team work and communication; specific comments were in support of engineers "being creative", and marketers "giving customer feedback to engineers".

The major role that both IT and CSOM students expect engineers to fill is that of implementing the development process; the most common comments were "develop a prototype" and "determine design characteristics". Neither group feels that marketing should play much of a direct role in the actual development process. Likewise, both constituents expect that the major role of marketers is to understand market and customer issues; this includes determining distribution channels, pricing, and advertising needs.

Several interesting differences in opinion exist regarding role expectations. First, several IT students think that engineers should be responsible for containing/managing the cost of the product, but no CSOM students mention this. Likewise, several CSOM students think that marketing students should be responsible for obtaining project funding, but no IT students mention this.

Finally, there is inconsistency in beliefs concerning who is responsible for understanding customer needs. IT students believe more than CSOM students that engineers should be directly responsible (in conjunction with marketing) for understanding customer requirements; CSOM students believe that marketing should own such a responsibility, and instead communicate such needs (in a mediated fashion) to engineers.

If engineers feel that they can perform customer analysis (almost) as well as marketers, this will lead to an imbalance in what each role thinks of the other in terms of value-added to the development process. Gupta et al. (1986) found that marketing perceives that it provides greater value to engineering than engineering perceives it gets from marketing. In high technology environments, these perceived value imbalances can lead to marketing being effectively "shut-out" from the development activities (Workman, 1993).

In summary, IT and CSOM students: (a) believe that their own role in the team should fit the archetypal image of their functional identity, and (b) believe that other team members should also conform to such archetypes. This in itself is not surprising; in the following sections, we shall investigate specific reasons why these archetypes exist and the nature of their power, and when individuals might step out of such archetypal roles.

Institutional Effects

Both universities and traditonal industrial organizations are organized around functional specialties, or disciplines. A University and its associated academic disciplines wield great influence over anyone who comes in contact with them--in an organizational sense, universities and academic disciplines are considered “institutions”. Scott states “institutions consist of cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior” (Scott, 1995, p. 33). Institutions shape the thought processes of their participants, helping define what is right and wrong, what is appropriate and inappropriate, what is desirable, and in general, how the world should be cognitively framed. Actors in institutions will tend to act in ways that maximize legitimacy, sometimes regardless of whether such actions enhance performance. This phenomenon is not unique to academia, and occurs often in industry as well.

A key outcome of the institutionalization process is a “role”; a role is a specialized set of values and norms appropriate to a subset of individuals within the organization. Roles act as prescriptions of what should and should not be done, and these prescriptions are held as expectations by both the actor and those around her. Roles “confer rights as well as responsibilities, privileges as well as duties, and licenses as well as mandates” (Scott, 1995, p. 38).

Within the academy, individuals in the role of “student” are expected to conform to various institutional norms such as showing up to class, working towards a good grade, doing assignments and taking exams, and in general being subservient to the teacher in terms of decision authority and power. Norms shape not only the role of students, but the roles of teachers and the industrial sponsor. Institutional theory predicts that in such situations the realized roles of these actors will tend to be isomorphic across different actor-sets and University settings (DiMaggio & Powell, 1983). Cross-disciplinary student design teams will tend to look the same whether they represent University of Minnesota students working with Medtronic or University of Illinois students working with Caterpillar.

Note that institutional theory is focused on the emergence of isomorphic structures and processes, not outcomes. In the context of new product development, there are no "right answers"; there is not a single viewpoint which represents the correct way to frame the situation. Rather, institutional effects shape the way in which teams are structured and behave, the way in which they interact with others (teachers and sponsors), and the way in which success and failure tend to be defined.

Besides the institutional effect of the academy and its associated roles, students are also influenced by their associated academic discipline. Academic disciplines also shape the way in which individuals view their own roles and the roles of others. According to Scott and Backman (1990, p. 290) "disciplines rule by controlling belief systems. Their primary weapons are ideas. They exercise control by defining reality--by devising ontological frameworks, proposing distinctions, creating typifications, and fabricating principles or guidelines for action". Disciplines tell actors which problems should be addressed, how they should be addressed, and what their outcome should look like. As such, they define both a frame of mind (cognitive) as well as a frame of action (normative).

Disciplines create thought-worlds that create differences in how individuals aspire and set goals, what needs they have, and what they are motivated by. Saxberg and Slocum (1968) for example found that engineers seek peer recognition, while marketers seek organizational recognition; engineers seek autonomy while marketers seek procedures and rules; engineers believe they are contributing to societal knowledge while marketers believe they are contributing to organizational success; engineers seek external validation (e.g. patents) while marketers seek internal validation (e.g. pay and promotion). Griffin and Hauser (1996) confirm that subsequent research supports Saxberg and Slocum's earlier findings.

For example, using the data discussed previously, consider the issue of product cost and price. When engineers frame the problem, the word-symbol "cost" is used and becomes an issue to be addressed internally, via the selection of materials, components, and processes; cost targets exist as constraints. When marketers frame the problem, the word-symbol "price" is used and the problem is framed externally; price is a product attribute through which market placement occurs. If product cost is too high, the engineer is likely to view it as a failure of product design; the marketer is likely to view it as a failure of engineering to understand market requirements. In summary, disciplinary differences lead to problems being framed quite differently--and hence, suggested interventions may also be different.

Disciplines also shape the perceptions of legitimate roles by highlighting certain concepts and tools and not highlighting others. For example, a recent book on engineering design (Pugh, 1991) makes almost no mention of methods to determine customer needs, technology and market strategy, and types of development products and projects. It states that the role of marketing is "(to) establish the nature and characteristics of the product to be made by means of market research... (and) the marketing of the final product" (Pugh, 1991, p. 149). Similarly, a recent book on marketing (Kotler, 1988) contains a few pages of general comments (out of over 750 pages) on the role of engineering in new product development.[iii] In summary, students from these disciplines--

unless they have work experience to the contrary--walk into their first assignment in a cross-functional team with little idea of what the other function's role truly is.

Individuals tend to conform to institutional norms because it gives them legitimacy. Legitimacy accompanies the enactment of appropriate behavior because social interactions become more regular, predictable, and controllable. Legitimacy accompanies the adoption of appropriate belief systems because it simplifies the choice of competing schema and leads to cognitive consistency with both self and group (Scott, 1995).

> Proposition 1: Institutional effects cause team members to seek legitimacy by adopting archetypal role expectations, despite their knowledge that strict adherence to such stereotypical roles may hinder optimal team performance.

<u>Learning with Limited History</u>

The student design team finds itself in a novel situation. For many, this experience represents their first participation in a cross-functional team and/or a new product development team; for all it represents the first time that they have interacted with specific other individuals. There is limited history to demonstrate what is appropriate and what works. Under these circumstances individuals will tend to select cognitive templates and behaviors that are known as legitimate.

To the degree that role expectations are the result of an institutional effect and hence consistent across individuals, multiple interpretations of the team's short and emerging history, and hence dissonance, will be minimized (Sproull & Hofmeister, 1986). Because archetypal role expectations are in part anticipatory, they tend to be reinforced even in absence of action (Merton, 1968). Role expectations are also reinforced as actors take action and learn who they are (Weick, 1979). If a critical incident (good or bad) occurs which happens to conform to archetypal role expectations--such as a “best practice” being implemented by the appropriate archetype role (e.g. a marketer performing a customer needs analysis)--it will cause role expectations to further strengthen and converge (March, Sproull, & Tamuz, 1989).

> Proposition 2: Limited learning opportunities cause team members to seek legitimacy by adopting archetypal role expectations; these role expectations are further reinforced by role enactment.

Cross-functional Teams

In a cross-functional team, differing disciplinary resources are brought together to ensure specialization and integration (Weick, 1979). Resource dependency theory states that as task complexity increases, so does functional interdependency (Pfeffer & Salancik, 1978). In light of such dependencies, cross-functional teams can be initiated for the purpose of laterally coordinating autonomous functions to implement the organization's strategy (Lawrence & Lorsch, 1967; Olson et al., 1995). Cross-functional teams create multiple perspectives, tending towards more holistic and creative decisions. These differences in perspectives may also lead to communication barriers (Hoffman, 1979); breaking down such communication barriers is often a key to success (Cooper, 1984; Souder & Moenaert, 1992). Such barriers are more likely to exist in projects that are more radical than incremental (Pelled & Adler, 1994).

Members of cross-function teams will value their team members if they perceive that the value of information they are getting from the other function is high. In general, the perceived value of information provided by the other function increases as:

(1) the information received is perceived as directly relevant,

(2) the information received is novel,

(3) the information received is credible (written media convey more credibility than interpersonal media),

(4) the information received is comprehensible (interpersonal media convey more comprehensibility than written media),

(5) the quality of the interpersonal relationship between the two individuals increases, and

(6) an individual is exposed more often to the concerns and issues of the other function (Moeneart & Souder, 1996).

Specific claims have been made that cross-functional teams enhance the probability of new product development success (Hise et al., 1990; Ancona & Caldwell, 1992; Takeuchi & Nonaka, 1986; Griffin & Hauser, 1996). Cross-functional development teams often take the form of organic, participative structures (Orrock and Weick, 1990) where power is decentralized, fewer rules and standard procedures exist, high autonomy exists, decision making and conflict resolution is participatory, rewards are team-based, and focus is project-based (Olson et al., 1995). This stands in contrast to the strong pull of institutional effects, which tend to generate less autonomy and more standard rules and procedures. Thus, individual team members may feel a constant tug between the desire to conform to institutional norms and the desire for autonomous behavior.

Regardless of whether the influence is more internal (via team dynamics and the contingency of the situation) or external (via institutional effects), group norms are an important element in the cross-functional team process (Donnelon, 1995; Denison, Hart, & Kahn, 1996). Group norms support self-regulation, situation scanning, and strategy planning (Hackman, 1987). Specific methodological tools can help establish such norms; for example, quality function deployment (QFD) can help facilitate interdisciplinary communication and agreement (Griffin & Hauser, 1992).

Functional diversity is a key determinant of team success (Clark, Amundson, & Cardy, 1997). Such diversity however makes it difficult for a team to act and think in a coordinated fashion (Dougherty, 1990; Hackman, 1987). Cross-functional teams "are less often teams with a high degree of interdependence, a group task, and a strong group identity than they are co-acting work groups composed of independent, highly competitive individuals who pursue their own goals over those of the team" (Denison, Hart, & Kahn, 1996, p. 1009). Top management can design the organizational context that leads to successful cooperation between functions (Song, Montoya-Weiss, & Schmidt, 1997). Strategies typically include collocation of team members, personnel movement, informal social systems, organizational structure, incentives and rewards, and formal integrative management processes (Griffin and Hauser, 1996).

Proposition 3: Team members adopt archetypal role expectations, because they lead to efficient use of organizational resources.

Enactment of Role Expectations

Students were asked the questions: “Name one instance where a business student made a significant contribution to your project? Name one instance where an engineering student made a significant contribution to your project?” Results were aggregated using the affinity method. We used best practice categories that had been previously identified in another project within our research program (Dooley, et al. 1996) to aggregate the responses. Best practice categories used were:

(a) cross-functional integration: an engineer contributing to a marketing task, or a marketer contributing to an engineering task

(b) forward thinking: planning, strategizing

(c) open communication: planning, designing, and/or implementing communication systems that enhance group effectiveness

(d) customer focus: understanding customer requirements, understanding market and competitive environment

(e) functional competency: developing a prototype, understanding technology, determining engineering design criteria, concept selection (for engineers); develop a business and marketing plan (for marketers)

(f) development process: planning, designing, and/or implementing an effective development process

(g) strategy: determining market, business, and/or technology strategic fit

(h) spirit: encouraging team members to persevere in lieu of setbacks; motivating.

Results are shown in Table 3; results were consistent between IT and CSOM students.

--place Table 3 here--

Engineers demonstrated their main value via functional competency (0.76), and marketers via customer focus (0.48); if one assumes that the functional role of marketing is customer focus, then adding “customer focus” to “functional competency” yields 0.67. In other words, individuals demonstrate significant value to the group by enacting their archetypal role expectations. It is interesting to note that IT students noted significant contributions that CSOM students had made to the actual development process, even though they noted earlier that such was not the role of marketing (see Table 2).

Proposition 4: Team members’ archetypal role expectations are enacted.

Novelty in Role Expectations of Others

As mentioned earlier, students tend to possess strong notions of what the role of their own function is, but very little notion (except at a stereotypical level) of what the role of other functions is. Is there a relationship between these role expectations and what individuals come to believe is "critical" to team success? In other words, what is more important: their own function's contribution, or the other function's? Students were asked to list the three most important concepts which led to successful new product development. Answers were aggregated using the affinity method and according to the categories used in Tables 1 and 2. Results are shown in Table 4.

--place Table 4 here--

There is consistent opinion that teamwork and communication are needed for success; there is also some opinion that strategic fit is important. Overwhelmingly, CSOM students look to the other function's responsibility (development process) as critical, and IT students do the same (market and customer). In other words, what is most critical is the role of the other function.

There are two possible explanations for this. First, there may be perceptions of blame--critical incidents and/or mistakes might have occurred and blame is being placed on the other discipline. Thus, the thinking might be "in order for the team to succeed, the other function must carry their weight; it is a given that my function will." Second, there may be some cognitive novelty in learning what true cross-functional development is all about. Information concerning their own role expectations may seem like "old-hat" and tend to go unnoticed, whereas exposure to information concerning the role of other functions may be new and treated as a significant differentiator between success and failure.

Proposition 5: Team members will tend to emphasize the importance of the other function's role in their beliefs of what will make the project succeed.

Stepping Out of the Archetype

An important aspect of working effectively in a product development team is gaining an understanding of and respect for the roles of all team members. Engineers need not be marketing experts, but they do need to understand what marketing does, why it is important and why it is difficult. Likewise, team members from marketing must know enough about engineering to recognize what is simple and what is not. A team where each member has an appreciation for what the other does can operate far more efficiently with much less time wasted on explicit or implicit unproductive paths.

In the student teams, we have found the ability to understand ones non-native area of expertise comes most easily when team members take on tasks outside of their training. On the Aetrium team, a business student was able to appreciate the way an engineer researches and selects purchased components by taking charge of selecting a high-resolution linear position encoder. One of the lessons she learned was that design requirements should not be viewed as fixed entities, but rather must be continually bartered

against each other in order to fit what is available to what is needed. Now she understands why it is that a seemingly simple task like picking a DC servomotor can take inordinate amounts of time.

On the Spinal Designs team, the three engineers conducted some of the interviews with Physical Therapists to gather preliminary voice of the customer data which was used to help define the medical device created by the team. In many product development efforts, product specifications come from marketing to engineering without much explanation, and engineering makes an attempt to design to those specs. By conducting the interviews themselves, the engineers quickly realized that most customer-driven specifications for a product are indeed quite fuzzy, and that there is often considerable latitude for exploring optimal solutions which may bend the perceived specifications. The engineers also learned that comprehensive, quantitative market information is exceedingly difficult to acquire and that more often than not, design teams must make choices based on imperfect knowledge of the customer.

Individuals will tend over time to relax their archetypal boundaries. “Although everyone may have been assigned a role, most often contained within a functional discipline, individuals often step out of their roles on various occasions. Decentralization and low formalization are expected to stimulate role flexibility” (Souder & Moenaert, 1992, p. 501).

The level of autonomy that the team has minimizes institutional effects and heightens the importance of team cohesion. In the extreme, skunkworks (or tiger) teams (Clark & Wheelwright, 1993) may care little for the formal roles established by the bureaucracy, and may simply reorganize work, roles, and responsibilities according to what is needed most at any given time, and who would like to do them. Roles may in fact change over the life cycle of the project, as specific informational and task needs arise.

> Proposition 6: As team autonomy increases, team members will more frequently enact roles that are contrary to the corresponding functional archetype role.

The other attenuator of strong functional boundaries is time. "When team members have worked together for a while, they should be less inclined to categorize and stereotype based on functional differences" (Pelled & Adler, 1994, p. 25). Once again, as boundaries within the team erode, team members may find little value in retaining the boundary definitions established by the bureaucracy.

> Proposition 7: As team members gain experience in a cross-functional team environment, team members will more frequently enact roles that are contrary to the corresponding functional archetype role.

Legitimate Practices

All things being equal, individuals and teams will enact practices that lead to success. All things are not equal however. Individuals are rationally-bound, making it difficult for them to determine reliable cause and effect rules (March, 1994). Limited learning opportunities will detract from the team's ability to use trial and error learning as an effective means to establish what practices to engage in (March, Sproull, & Tabuz, 1989). Thus, institutional effects will favor legitimacy over perceived benefit (Scott, 1995).

In the specific case of our student teams, this search for legitimacy is especially strong. First, the teacher(s) stands as a judge of quality and will in fact hand out rewards (grades) according to such judgments. Because of the lag between cause and effect, the ambiguity of defining success, and the complexity of cause and effect, the teacher often will not be able to make any reasonable judgment as to whether a team's or individual's actions were actually effective from a performance or outcome standpoint. They can only judge the quality of the action by its legitimacy.

Legitimacy is also required, because the students must justify their actions to the industrial sponsor, who (a) is paying a significant fee to participate and also allocating significant personnel time to interact with the student teams--and thus has a lot invested in the outcome of the project, and (b) has significantly more experience at developing new products than the team members. Therefore student and team actions are likely to conform very strictly with new product development practices that are well established and legitimized.

> Proposition 8: Team members will enact practices that are considered as well established and legitimate by the institution.

Through readings and lectures, students are exposed to a wide range of best practices. During the course of the year, however, only a subset are likely to be embraced by all the teams.

Most teams readily buy into the concept of customer-driven design. Although it takes a little longer for those with engineering background to fall into line, the idea of thoroughly understanding customer needs before a product is finalized appears to have intuitive appeal to novice teams.

Cross-functional activities are embraced by most teams, perhaps because we stress it emphatically in the course. The idea of getting out of you own expertise comfort zone and undertaking tasks for which you were not trained is appealing to most students. Further, most teams have engineers participating in voice of the customer activities and business people participating in brainstorming, component selection and assembly of prototypes.

Sessions for reflection on the development and team process is not part of most teams efforts, unless explicitly required by the course instructors or corporate liaisons. The utility of regular team self performance reviews is not apparent to most.

The actual practices teams enact will also depend on the situation that they find themselves in. These situational contingencies will not change the set of practices that are legitimate, but will change the selection process. Using event history file methods, a tally of "best practices" was made (each event could potentially be tallied once for a particular best practice), using the categories shown before. The event history method (Van de Ven & Polley, 1992) involves developing a longitudinal case study, breaking the case study up into discrete events, and the coding each event with conceptual labels. The labels are chosen for relevancy relative to the theory being tested. Two teams were studied: the Horton Team and the Spinal Designs Team. The Horton Team case was broken into 126 events from October 1996 until February 1997; the Spinal Designs Team consisted of 129 events over the same period. Table 5 shows the raw counts (they are roughly comparable because the total numbers of events is almost equivalent) for each best practice category.

--place Table 5 here--

Both teams showed few instances of cross-functional integration or technology searching; both teams focused on planning efforts, communication, and understanding the customer. A Chi-Square test shows that the two teams engaged in different best practices with different frequencies (p=.11, chi-square=10.6, df=6).

Proposition 9: Team members will enact practices according to situational contingencies.

Where do students learn of this set of legitimate practices? Students were asked to identify the most common sources of such learning. Results are shown in Table 6.

--place Table 6 here--

IT students learn from a greater variety of sources than do CSOM students. CSOM students learn primarily from the professors, prior coursework, and their teammates; IT students learn primarily from the professors, lectures, and the industry sponsor. Here are some examples of such learning pathways.

Students learning from professors. We have found that students will listen to professors in the abstract, but often will not be willing to try what they have learned in the classroom on their projects. Most likely this comes from the stereotype students have of the academy where what you learn in the classroom is not what really goes on out in the "real world".

For example, although House of Quality (HOQ) methods were covered in class, in the text materials, and suggested by the professors as a valuable method to codify the link between customer needs and design requirements, not one of the six teams chose to build and use a HOQ. In past years, HOQ was used by student teams if it was part of the sponsoring company culture. For example, 3M regularly uses HOQ so the team working with 3M that year, built a comprehensive house which added real value to there development effort.

Thus, the institution is a very powerful force in determining best practices. Teams tend to follow company culture in new product process, and changing that culture to introduce new best practices requires champions within the corporation who have support from upper management and credentials with the product development teams. In our student teams, we have found minimal team-initiated experimentation with novel best practices, but rather that teams tend to follow new product process as it has been practiced by the institution in the past.

Students learning from other teams. One of the great advantages of running multiple product development teams with different corporate sponsors in one class is that teams can observe and learn from other teams. We have startup company projects learning from large corporate projects, OEM projects learning from consumer projects, medical projects learning from industrial projects. Although this is simple to do in a class, it might also be beneficial for companies to set up a system whereby multiple internal product development teams can have occasional interaction to share what they have learned about process.

For example, two of our teams this year are working on related, but not competitive medical products. Through occasional interaction, they have been able to determine that their estimates of market size were consistent, even though they were derived using independent methods and sources.

Proposition 10: Team members will learn of legitimate practices from a variety of sources.

Putting all ten propositions together, we have a model that posits the following. Institutional effects, limited learning opportunities, and the desire to use resources effectively causes individual team members to adopt archetypal role expectations of self and others. These role expectations cause the individual to believe that the other role's contribution is critical to team success. These archetypal role expectations are enacted; individuals may step out of such archetypal roles as team autonomy increases and individuals gain more cross-functional experience. These role expectations shape the practices that are enacted by the team. Teams select practices that are considered legitimate, and they learn of such practices from a variety of sources. Situational contingencies also influence the exact practices which are engaged. The model is shown in Figure 1.

--place Figure 1 here--

Conclusions

This theory building exercise demonstrated the strong archetypal roles that team members adopt and enact in cross-functional product development teams. These role expectations shape team member perceptions of what is critical to team success, and cause practices to be engaged. The team selects practices to engage in from a set of legitimate practices, provided to them from a variety of learning sources. Situational contingencies shape the actual practices engaged.

One may question how generalizable our results are. Institutional theory would certainly suggest that our results are generalizable to other cross-functional student design teams in other universities. These results may also be generalizable to newly-formed cross-functional product development teams, especially where team members may have little or no similar team experience. The results should generalize to teams with more than two functions, and/or functions different from marketing and engineering. Finally, there is no reason to believe that the focus of the teams--new product development--caused any special results; these results should be expected in other cross-functional teams focusing on such things as quality improvement, process redesign, and organizational design.

Can existing research in new product development teams create insight into these students teams? Clark and Wheelwright (1993) define four different types of teams relative to the amount of autonomy they have. A functional team, such as one might find in an R&D environment, sits at one end; a skunkworks (completely self-directed) team sits at the other. Lightweight teams are cross-functional but individual team members still report to a functional manager; heavyweight teams are cross-functional and semi-autonomous and individual team members report mainly to a project manager. The student teams resemble in character and structure heavyweight teams. Table 7 shows the general responsibilities of each actor according to Clark and Wheelwright (p.542-545); students play the role of the heavyweight team member, the teacher plays the role of the project manager, and the industrial sponsor plays the role of the management sponsor.

--place Table 7 here--

Clearly more research is needed to examine in more depths the issues brought up in this paper. For example, the exact nature of the learning process needs to be researched in greater detail. How exactly are particular practices selected? What do students do in light of failure? Is the effect of situational contingencies really that strong? These and other questions will be examined as this research continues forward.

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Figure 1: Archetypal Roles and Enacted Practices in Cross Functional Teams

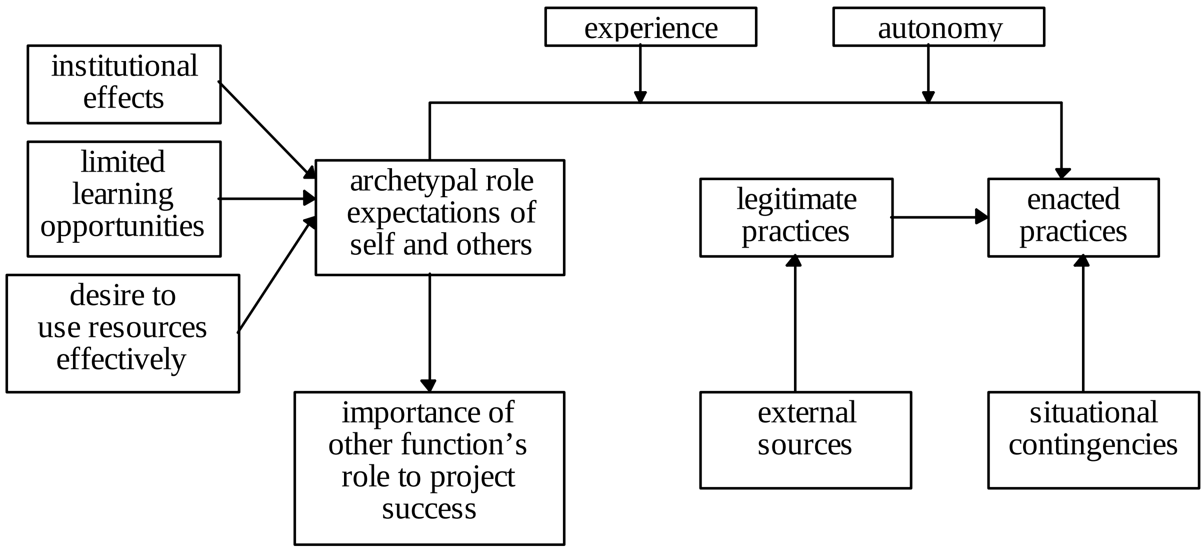

Table 1

Appropriate Role of Engineering Students (frequency of response by group)

	IT	CSOM	Total
market and customer focus	.37	.25	.33
strategic fit	0	0	0
resources and support	0	0	0
teamwork and communication	.16	.19	.17
development process	.47	.56	.50

Table 2

Appropriate Role of Marketing Students (frequency of response by group)

	CSOM	IT	Total
market and customer focus	.76	.93	.85
strategic fit	0	0	0
resources and support	0	0	0
teamwork and communication	.10	0	.04
development process	.14	.07	.11

Table 3

Observed Best Practices Engaged in by Engineers and Marketers (proportion of total response shown)

Best Practice	engineers	marketers
cross-function integration	.12	.10
forward thinking	0	0
open communication	0	0
customer focus	0	.48
functional competency	.76	.19
development process	.06	.14
strategy	.06	.10
spirit	0	0

Table 4

Factors Leading to Success of New Product Development (frequency of response by student type shown)

	CSOM	IT	Total
market and customer focus	.17	.32	.27

strategic fit	.04	.13	.10
resources and support	.13	.05	.08
teamwork and communication	.26	.38	.33
development process	.39	.11	.22

Table 5

Number of Best Practice Events, Horton Team vs. Spinal Designs Team

Best Practice	Horton Team	Spinal Designs Team
cross-function integration	14	10
forward thinking	23	35
open communication	24	29
customer focus	15	29
functional competency	21	16
development process	14	15
learning about technology	8	15

Table 6

<u>Learning Sources for Legitimate Practices (proportion response by student type)</u>

Source	CSOM	IT	Total
textbook	.02	.10	.09
lectures	0	.15	.11
professors	.22	.21	.21
industry sponsor	.11	.15	.14
previous work experience	.11	.10	.11
engineering students	.17	.03	.07
business students	.17	.10	.12
consultation with people at work	0	0	0
prior coursework	.17	.03	.07
Internet	0	.05	.04
magazines	0	0	0
journals	0	.03	.02
my team	0	.03	.04

Table 7

<u>Heavyweight Team Roles</u>

Student Team Member	Teacher	Industrial Sponsor
ensuring functional expertise	market interpreter	resource commitment
representing functional perspective	multilingual (multifunctional) translator	milestone reviews
sharing responsibility	direct engineering manager	transition plans
planning and executing tasks	program manager “in motion”	cross-project issues
engaging in team process	concept infuser	
examining issues holistically		

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[ii] contact Kevin Dooley, Arizona State University, PO Box 875906, Tempe AZ 85287-5906
[iii] Our courses use books which <u>do</u> demonstrate the role of both disciplines: Ulrich, K.T. and Eppinger, S.D., *Product Design and Development*, McGraw-Hill, 1995; and Urban, G.L. and Hauser, J.R., *Design and Marketing of New Products*, 2nd Ed., Prentice Hall, 1993.