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Integrators, not Generalists Needed: A Case Study of IPD Teams at Textron Defense Systems

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Best practice studies in integrated product development (IPD), including research on lean manufacturing practices, all point toward the use of cross-functional teams (Womack et al., 1990; Clark & Fujimoto, 1991;Susman & Dean, 1992). Although, success within cross-functional teams is dependent upon many factors, one differentiating factor appears to be group processes (Susman & Dean, 1992). Effective group processes rely on team members being able to communicate with one another and synergistically integrate their skills and knowledge throughout the development process.

In the manufacturing arena, research has suggested that redundancy of skills leads to enhanced flexibility in that team members can fill in for one another in case of absence (Emery, 1967; Cherns, 1978; Hackman & Oldham, 1980; Weisbord, 1987; Orsburn et al., 1990). Such multiplicity of skills in IPD teams may not be feasible, although many managers argue what they need is fewer specialists and more generalists. But the term generalist implies a “jack of all trades, master of none,” and, in the world of product development, expertise is required. In fact, professionals are concerned that they may lose their “professional identity” as their organizations move toward cross-functional teams (Donnellon, 1993; Klein, 1991).

The research on cross-functional development teams recognizes the tension between a functional versus product focus. For example, the notion of “heavy weight teams” provides professionals with a tie back to their functional roots (Clark & Fujimoto, 1991). But as organizations move toward co-location and horizontal product teams (with the extreme being the abolition of traditional functional groups), fears of expertise dilution abound.

The following case study examines an organization that essentially eliminated traditional functional groups and assigned all employees to cross-functional product or process teams. Although the organizational and cultural change occurred throughout the enterprise, this case will focus primarily on the structure of teams and the management of skills and capabilities within the IPD core process. In the IPD area, multi-disciplinary teams were established with the expectation that individuals would both retain their own area of expertise and broaden their understanding of the functional expertise of their fellow team members. In essence, team members were expected to become “integrators,” as opposed to “generalists.”

Although a major cultural change has occurred over a two-year time period, the change to date is considered as only the first step in an evolutionary process. The transition of this organization from a traditional matrix with strong functional hierarchies to a team-based structure highlights a number of human resource implications, including team selection, performance evaluation and rewards, and career paths. The study will conclude with a summary of lessons learned and the applicability of such an organization to the defense aircraft industry.

Textron Defense Systems (TDS)

In 1986, TDS was at its peak employment level of over 6,500 employees and organized around a fairly traditional matrix structure with strong functional silos. At that time there were seven levels within the functional areas - president, vice-presidents, functional directors (e.g., mechanical, electrical), managers, section chiefs, group leaders and employees (e.g., engineers).

As employment began a gradual stairstep decline, TDS management began to de-layer the organization. Concurrent with the elimination of section chiefs and group leaders in 1990, programs were aligned along three major business areas tactical, strategic and surveillance. Each business line vice president had total responsibility for program management, business acquisition and technical resources (engineering and manufacturing). As such, the functional organizations were decentralized to the business lines. This often meant a duplication of resources within each business line.

In Spring 1992, it had become obvious that the current organization would inhibit the division's ability to meet its five year strategic goals, particularly in the area of controlling overhead and indirect labor. Hank McCard, President of TDS, established a task force, comprised of four vice presidents (Tactical, Surveillance, Communications, and Finance), to investigate the organization of the future. After several months of reviewing readings, attending a session on systems dynamics, and brainstorming ideas, the task force recommended a set of the principles (listed in Exhibit 1) upon which the new organization should be built.

These principles were based, in part, upon a review of TDS's own history. Whenever a program had gotten into trouble under its matrix organization, key personnel were co-located into a team dedicated to fix the problem. Once the crisis had passed, the team dispersed. Upon reflection, the task force concluded that the functional structure was part of the problem and suggested abolishing the functional groups and restructuring TDS around core processes. Building upon the task force's input, McCard designed the new organizational blueprint.

Exhibit 1: TDS Principles
CUSTOMER FOCUS – customer satisfaction drives performance – maximize customer awareness and contact throughout the organization to achieve alignment
COMPETENCIES – identify core competencies and leverage those that are strategically important – make general and multiple competencies the personnel development rule
STRUCTURE – organize around process, not function – flatten hierarchy through minimizing process subdivision and non-value added activities
ROLES/RESPONSIBILITIES – senior leaders as process owners who set vision and make demands – combine managerial and non-managerial activities
SYSTEMS – reward team performance and individual skill development – information and training on “just-in-time-to-perform” basis
SUPPLIER FOCUS – responsible to internal and external supplier needs as well as receipient’s expectations

The new structure called for four layers—President, Vice Presidents, Team Leaders and Team Members—and all personnel belonging to one of six core processes. McCard assumed responsibility for leading the Business Acquisition Core Process Team (comprised of the vice presidents of Landing & Communications Systems, Surveillance & Missile Systems, Energy Technology, Sensor Fuzed Munitions Systems and Communications & Planning). The remaining vice presidents became “owners” of the remaining core processes (IPD[1], Finance, Production & Logistics and Supplier Quality) or support processes (Contracts, Computer & Industrial

[1] At TDS, IPD was usud interchangeably for both an organizational grouping under the responsibility of a vice president and a system for product development.

Services, Human Resources and Legal). To assist the core process owners (VPs), former functional directors became staff executives. Executives, who were given no formal line responsibilities, were expected to act as resources to the teams to provide mentoring, guidance and oversight.

In November 1992, TDS, which had downsized by then to 2100 employees, re-assigned each employee to one of 157 teams; 90% were either a product or process team (the remaining were administrative). Ownership of a product team changed as the product advanced into a new stage of its life cycle (i.e., IPD to Production), whereas process teams were permanently owned by a particular core process owner.

IPD Organizational Structure

As described in a Concept of Operations (CONOPS), which was written and presented to all personnel through a series of communication sessions during the first quarter of 1993, the execution of product development activities became the responsibility of dedicated multi-disciplinary teams focused on specific product or process areas. Hence, all 400+ IPD personnel were assigned to either a product or process team. Core processes, however, remained the home base for training and career development and, in the case of downsizing, layoff decisions.

Each of the “core process owners,” i.e., vice presidents, was responsible for providing the product or process teams with needed personnel resources, capital assets, systems, tools, processes, and standards. In addition, as described in the CONOPs, core process owner’s role was to focus on resource management, process improvement and standards of performance. As such, they were responsible for:

- establishing and assuring the consistent application of a core process activity within all division product teams
- the continuous assessment of the state of the division’s strategic technology competencies and the responsive development of division core competencies that meet the product needs
- the allocation of technical resources among the product teams to assure the division meets its strategic objectives
- managing and supervising the technical and capital assets not directly assigned to product teams
- training and development of technical resources
- the management of assigned indirect, business & planning, marketing and capital budgets.

Due to the span of control and the need for linkage between business acquisition and technical development, two deputy roles were created to support seven of the eight product teams and four process teams; a director was also added to coordinate the remaining six process teams and a technical assets group. Although the deputies and the director represented an additional layer within the structure, there was no distinction made between teams that reported directly to the core process owner versus through a deputy or the director.

Executives

The executives in IPD were aligned by strategic competencies (electronic development, systems engineering, sensor & signal processing, information technology and test & evaluation) which matched their area of expertise. Their roles and responsibilities were focused on continuous improvement in processes, resources and performance standards within their domain of strategic competence. As such, they were responsible for:

- establishing process standards and assuring their implementation in all product teams
- the development and implementation of continuous process improvement
- identifying, evaluating and acquiring key technological advances necessary for the division to achieve its strategic objectives
- identifying and championing the acquisition of capital and/or human resources .

Although the executives had no direct control over the daily operation of the product and process teams, they wielded considerable power within the organization in that they were, in essence, first sergeants to the core process owners. As one executive noted, “We manage through the “Big I,” that is, influence.” Their influence stemmed from their expertise and their authority to decide staffing assignments, reductions and training (e.g., they determined who was on what team within a strategic competence). In addition, they managed the capital budgets and established and monitored the process standards used by the product teams.

Teams

Product teams were tied to a contract program and were identified with a single product, such as tactical smart munitions, surveillance or landing systems. They were fully staffed with all needed disciplines to execute their program and were responsible for managing their program within the processes defined by the core process owners. In many cases, due to of the development effort, product teams were organized into a hierarchy of sub-teams.

While the product teams were given responsibility to manage total contract costs, capital expenditures and indirect costs were managed by the core process owners. Resource needs were negotiated between the team leader and the core process owners. As such, product teams were focused solely on the current program, while the core process owners attended to upcoming programs and the business acquisition team concentrated on finding future business. The roles and responsibilities of the product teams were, thus, delineated as follows:

- responsible for cost, schedule and technical performance of contract

- responsible for product meeting customer and market needs and achieving production status
- has administrative responsibilities for all full time resources
- responsible for implementing process standards established by process owners
- responsible for actively supporting the resource allocation process within the division
- supports business acquisition activity to assure product retains user support needed to move through its life cycle
- interfaces with operation's technical director and resource manager to identify staffing needs/availability
- supports resource administrator in identifying personnel development, capital asset, and technology development needs.

Process teams served as internal suppliers of processes, such as laboratories. These were comprised of full-time team members who serviced product teams on an on-call basis. Although co-location was less feasible since process team members tended to service multiple product teams, laboratories at TDS were being consolidated and moved into an "overlay" position with respect to the product teams. For ease of use and efficiency, the laboratories were to be relocated one floor above that which housed product team office space.

There was also a small **Technical Assets** group, comprised of 15 individual experts, who were loaned on a part-time basis to provide specialized expertise to either product or process teams. Whenever an individual was loaned full-time for a period of three months or more, then that person became a member of the product team.

Reward Systems

To reinforce the new organizational culture, TDS was attempting to align reward systems with the new team-based structure. A variable pay plan was introduced in July 1993 and a skill based pay system was scheduled to be implemented in early 1994. (Previously, merit pay was tied directly to individual-based performance appraisals written by the supervisor of record, e.g., an engineer's functional manager.)

The variable pay plan (VPP) was designed to reward teams for productivity and goal achievement. Team goals were quantifiably tied to division goals through an iterative review and revision process. In 1993, team leaders met semiannually with their teams to rough out a set of goals for each team. Team leaders then reviewed their goals with their core process owners. Teams revised their goals, as deemed appropriate, and returned them to senior management for final approval. Starting in 1994, this process was to occur annually.

At the end of each review period, teams were awarded money proportional to their progress toward their objectives. Product teams were primarily measured against cost, schedule and technical goals of their programs, whereas process teams were evaluated on efficiency and productivity criteria, partially in the form of “grades” given by the resource consumers (i.e., product teams).

There were four under/over achievement hurdles. If a team achieved 100% of its goals, it received a baseline amount (based upon corporate budget guidelines on average annual employee compensation increases). When a team exceeded its goal by 20%, it received 175% of the baseline. On the other hand, if a team missed its goal by 10%, it received only 50% of the baseline amount, and if it fell short of its target by 20%, it received no variable pay.

The initial payout averaged 131% of the baseline for 1993 and was generally viewed as a positive incentive. Most teams distributed their payout equally among ail team members, but a team could choose to assign up to 25% of the total dollars based on individual contribution to the team. Several issues, however, surfaced which are to be addressed by modifications to the VPP in 1994.

One issue was the extent to which all team members should receive an equal share of the payout. Some argued that it be better to prorate a larger percentage of the team payout based upon individual contribution to the team. Furthermore, some team objectives where team dependent while others were merely a composite of individual efforts. Those teams that did weight contribution into the distribution had varying degrees of success relative to perceived fairness. The level of difficulty in achieving team goals also varied from team to team. Some team objectives were inherently more difficult or risky due to a creativity component or a dependency on others outside the team; some objectives were impacted by “out of team control” events (e.g., weather affecting a test). A further complication was that product teams tended to be more clearly focused on common goals than process teams. Product teams generally had more explicit and meaningful metrics such as milestone and cost targets and performance goals. Process teams generally had more difficulty in measuring accomplishments and were subject to more ambiguity. Finally, some team objectives were of greater strategic importance to the division than others or provided a greater degree of learning and positive change. Should these objectives receive a larger VPP payout?

To respond to these concerns, several changes were being planned for 1994, including raising the expected VPP payout to 140% of the baseline. In addition, individual team member contribution or value to a team was to be determined by a three step process, which had been piloted by twenty-five teams in the second half of 1993. The first step was an anonymous peer appraisal which would be provided in dialogue between the team leader and team members. This appraisal would form the basis for a peer rating score. In addition, each team was to assess its tasks and determine a difficulty rating for each task. Team members would then identify the percentage of time they spent on each task. The value of each team member was determined by multiplying the percentage of time spent on each task by its difficulty rating by the peer rating.

The individual team member contribution score was designed to identify top performers in each team. These top performers would then receive an additional bonus, above the team's variable pay. All team members would, thus, receive an equal payout of the variable pay, regardless of their contribution ranking. To avoid negative reactions from team members not receiving individual performance bonuses, a separate budget, above and beyond the VPP account, was set aside for performance bonus. In addition, to oversee these changes in the VPP, TDS established a Performance Objectives Review Board. The board must approve 1994 VPP team objectives and concur with each team's self assessment of how well they did. It is planned that the board will eventually (1995 expected time frame) establish difficulty factors for teams based on negotiated objectives.

A distinction was also made between teams and working groups (Katzenbach & Smith, 1993). Whereas teams required interdependent action to accomplish a common purpose, a working group was a small number of individuals who carried out prescribed tasks individually or in subgroups. Both product and process teams fit the definition of teams and team members would continue to receive their variable pay based on a negotiated set of team objectives. The technical assets team, however, was more of a working group and their variable pay was to be determined by summing the percentage of time spent on various teams multiplied by each of those team's payout.

Skills Register

A comprehensive Skills Register was generated as a first step in characterizing the mix of skills available at TDS for use in better matching personnel assignments to product teams. Skill categories were initially identified according to old functional models, e.g., electrical engineering, sensor systems, etc. Executives, along with input from team leaders and senior technical experts, then listed each team member's skills and ranked them as to entry, intermediate or advanced.

In June 1993, a second pass was then made by soliciting a self-assessment of skills by team members. All IPD personnel were asked to voluntarily rate their proficiency in 292 skills within 38 capability areas. Capabilities paralleled traditional job classifications (e.g., electrical engineer, physicist and team leader), while skills ranged from acoustic phenomenology/ analysis to knowledge of document control process to people skills. (See Exhibit 2 for the proficiency scale.)

Although the skills register was quite exhaustive, concern was raised within the IPD management team that it did not truly capture the subtleties of the skill mixes

Exhibit 2: Skills Register Proficiency Ratings

	Entry	Intermidiate	Advanced
Direction	requires definition of tasks	defines most tasks independantly	provides task definitions to others
Understanding	average within technical area	above average within technical area	above average across many technical diciplines
Problem Solving	solves basic problems	solves complex problems	solves complex integration problems
Decision Making	requires concurrence on decisions	makes some decisions independently	makes most decisions independently
Coordination	limited coordination skills	above average coordination skills	exceptional coordination skills

needed within product teams. Hence, as part of the data gathering for this case study, one product team was studied in an effort to further refine the definition of skill within IPD teams beyond generic functional capabilities and skills.

A survey (Appendix A) was administered to members of the Wide Area Mine (WAM) Sensor Systems product team, which was responsible for developing and testing the algorithms, software and hardware associated with the WAM sensor data. The team was comprised of engineers, physicists, operations analysts and technicians. Exhibit 3 outlines the team's major blocks of work.

Knowledge Maps

Mapping knowledge within IPD teams was a particularly difficult task in that knowledge evolves during the development process and different areas of

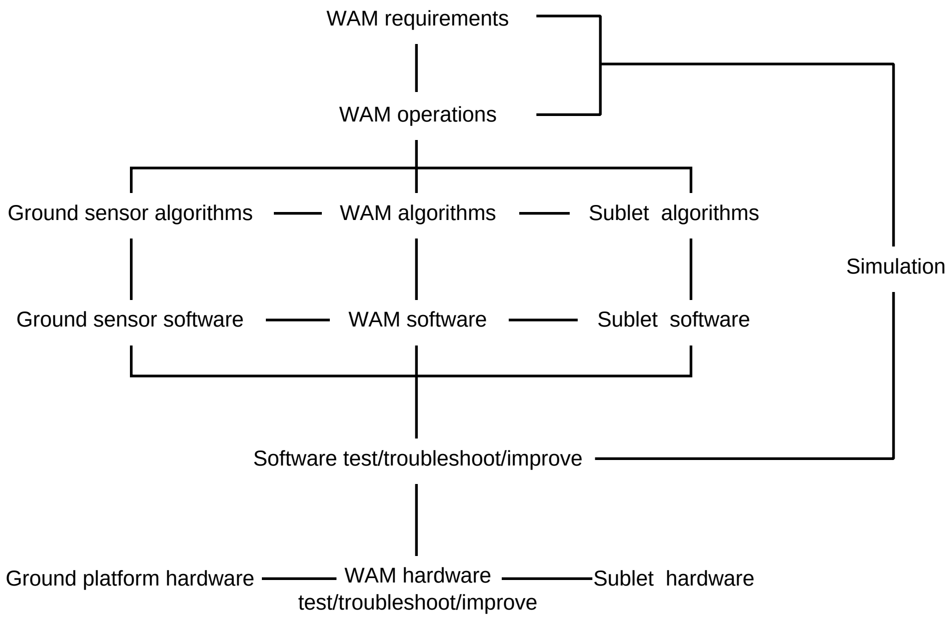

Exhibit 3: Outline of WAM Activities

expertise are often needed at the various design stages. With this in mind, this case study attempted to capture merely a snapshot of the skills needed within a subproduct team at one point in the development cycle. In line with the literature on work design (Emery, 1967; Cummings, 1978), WAM sensor systems team members were asked to identify the types of skill/knowledge required to perform their current activities.

In reviewing the responses, it became apparent that some knowledge was theory specific whereas some was application specific. For example, several team members identified the need for programming knowledge while others listed specific languages, such as “C” and “Paradox.” In further discussions with the respondents, it became apparent there were also differing levels of expertise concerning programming knowledge, ranging from following instructions in the manual (i.e., application only) to fully understanding the theory of programming. Using programming as an example, knowledge within a particular discipline can be depicted by a venn diagram, as shown in Diagram 1, which illustrates areas of overlapping knowledge sets.

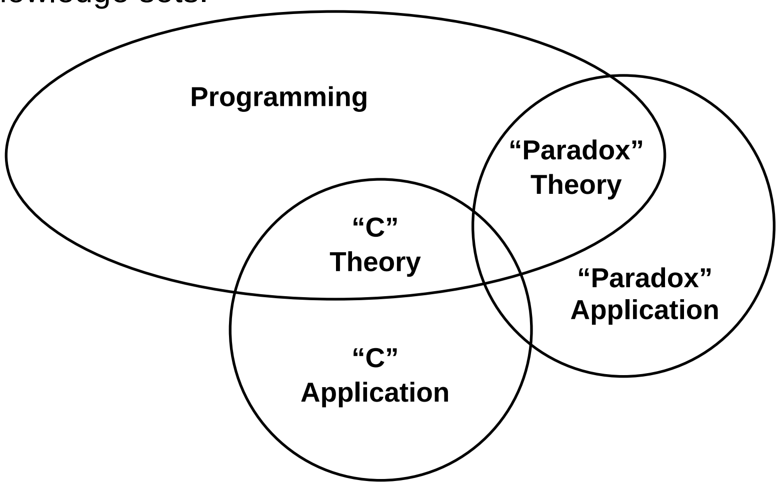

Diagram 1: Programming Knowledge Map

This is analogous to the types of knowledge often found in manufacturing groups operational, analytic and integrative (KIein, 1993). The theory area is similar to analytic knowledge, while the application could be thought of as operational knowledge, as shown in Diagram 2.

Although there are parallels to skill definition in manufacturing teams, there are two significant differences worth noting. First, the skill mix in manufacturing is less dynamic than in IPD. Although manufacturing skills evolve and tasks change through continuous improvements, the basic blocks of work are fairly constant on

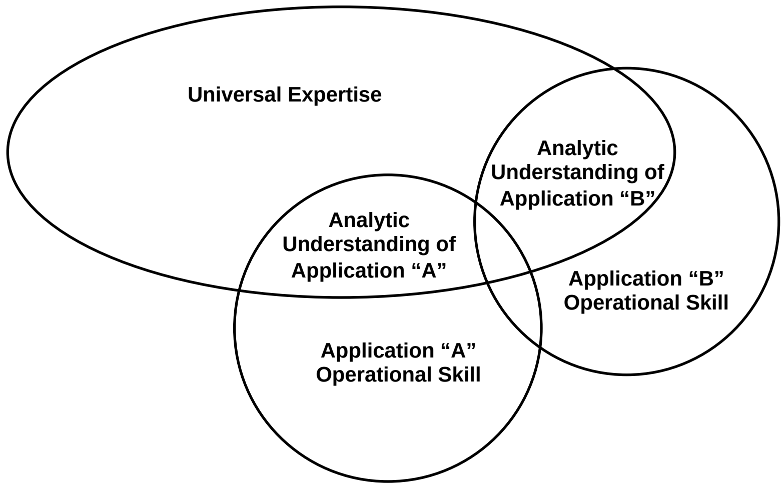

Diagram 2: Generic Knowledge Map

a day-to-day basis in comparison to product development. Second, there is less opportunity for rotation of IPD team members across individual team member assignments. In general, the specialized nature of functional expertise typically requires too great of a training effort (both in resources and time) to cross-train IPD team members.

In an effort to map the knowledge of the entire team, the responses from all team members were sorted as to knowledge or expertise required to do each major block of work displayed in Exhibit 3. It became apparent that there was some overlap between individual team members in many areas. Upon further investigation, it appeared that the overlap was not necessarily duplication of knowledge, but often varying degrees of expertise or different types (i.e., analytic versus operational). One particular task, sublet software development, will be used to illustrate our analysis.

Sublet Software Development

Diagram 3 depicts a map of seven fields of technical knowledge used in sublet software development. Signal processing, electronics, software development

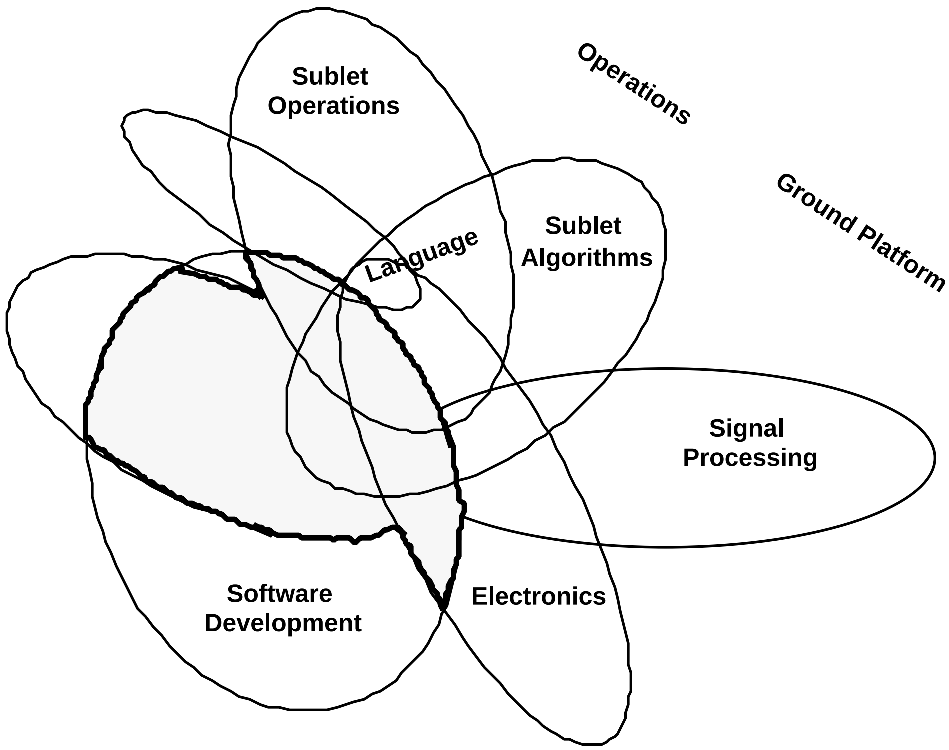

Diagram 3: Sublet Software Development Knowledge Map

(which includes analysis of requirements and writing the code) represent spheres of knowledge typically associated with traditional functional groups; knowledge of computer languages often falls within many different functions. Ground platform and sublet operations, as well as sublet algorithms, were output of previous steps in the development process and, hence, represent a synthesis of multiple disciplines. In order to use the algorithms, there had to be some understanding of the logic which was used in developing them. Similarly, the group developing the software also had to have some general understanding of how both the ground platform and the sublet were to operate. Hence, the shaded area in Diagram 3 represents the composite technical knowledge required to develop the WAM sublet software. (For purposes of this map, theory and application knowledge are both included within each knowledge area.) Since it would be rare for any one individual to possess all the requisite knowledge needed to develop the sublet software, the team, in total, had to cover the entire breadth of knowledge required .

Several points of clarification are necessary in the interpretation of the diagram. First, the intent of the diagram is to show overlapping areas and does not represent the relative magnitude of knowledge within each technical field. In other words, the diagram is not drawn to scale relative to the size of each knowledge area. Second, the frame of reference of diagram 3 is solely that of sublet software development. Similar maps could (and should) be drawn for both parallel and sequential tasks. These could then be overlaid to reveal areas of integrative knowledge needed to develop the entire product. Third, sublet software development did not require a complete understanding of any of the individual technical fields. For example, while in-depth understanding of signal processing was needed to develop the sublet algorithm, sublet software development required only an appreciation of how signal processing theory impacted the software, e.g., why the software program had to be written in assembly code for speed as opposed to a higher level language.

If the sublet software had been developed in a traditional matrix organization, the same pieces of knowledge would have been needed, but the integration of the individual functional experts would have been the job of a project manager (PM). For example, one scenario might have been that the project manager, who was probably the most knowledgeable concerning the ground platform and sublet requirements, had a general understanding of how both operate. The project manager delivered the algorithms, written by some system analyst, to a software developer. The software developer, who often personally wrote the code, was both an expert in software development as well as the specific computer language(s) to be used. If a question arose concerning signal processing or electronics capability, the software developer went to the project manager, who, in turn, set up a meeting with necessary experts in attendance.

In the case of an IPD team, the team leader (TL), while still an overall coordinator of the team, was less of a focal point for the integration of technical knowledge. The individual experts integrated their knowledge on a real-time basis, as shown in Diagram 4.

In order for integration to occur within an IPD, there must be some overlap of technical knowledge between each team member. In the case of sublet software

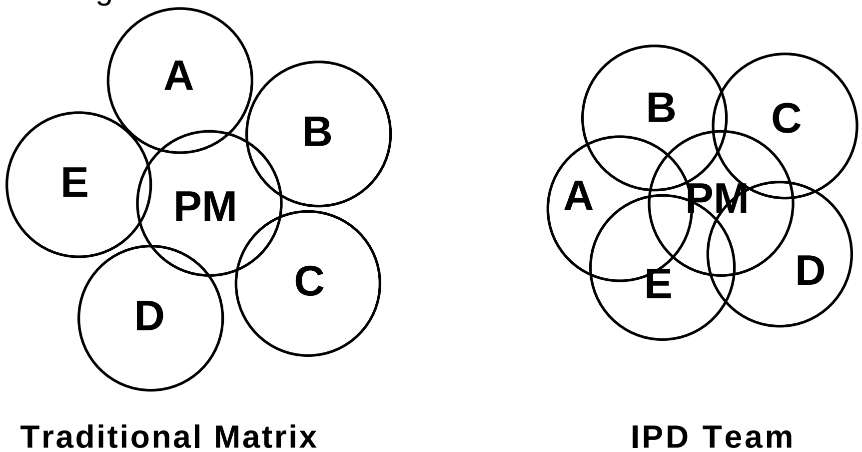

Diagram 4: Traditional versus IPD Knowledge Integration

development, three team members were necessary to cover the shaded area in Diagram 3. Diagram 5 maps the expertise of these three team members.

Team member A was an software engineer who was the software development and computer language(s) expert. She also possessed some peripheral understanding of the ground platform and sublet operations, as well as an ability to translate the algorithm documentation into the software. Team members B and C were needed, however, to incorporate signal processing and electronics expertise in the software. Fortunately, both possessed some understanding of software development and knowledge of the ground platform and sublet operations and sublet algorithms so that they could convert their knowledge into language team member A could understand. The areas of overlap in Diagram 5 were essential for the team to function. If only one team member possessed the overlapping knowledge, he/she would have become the coordinator, or de facto team leader.

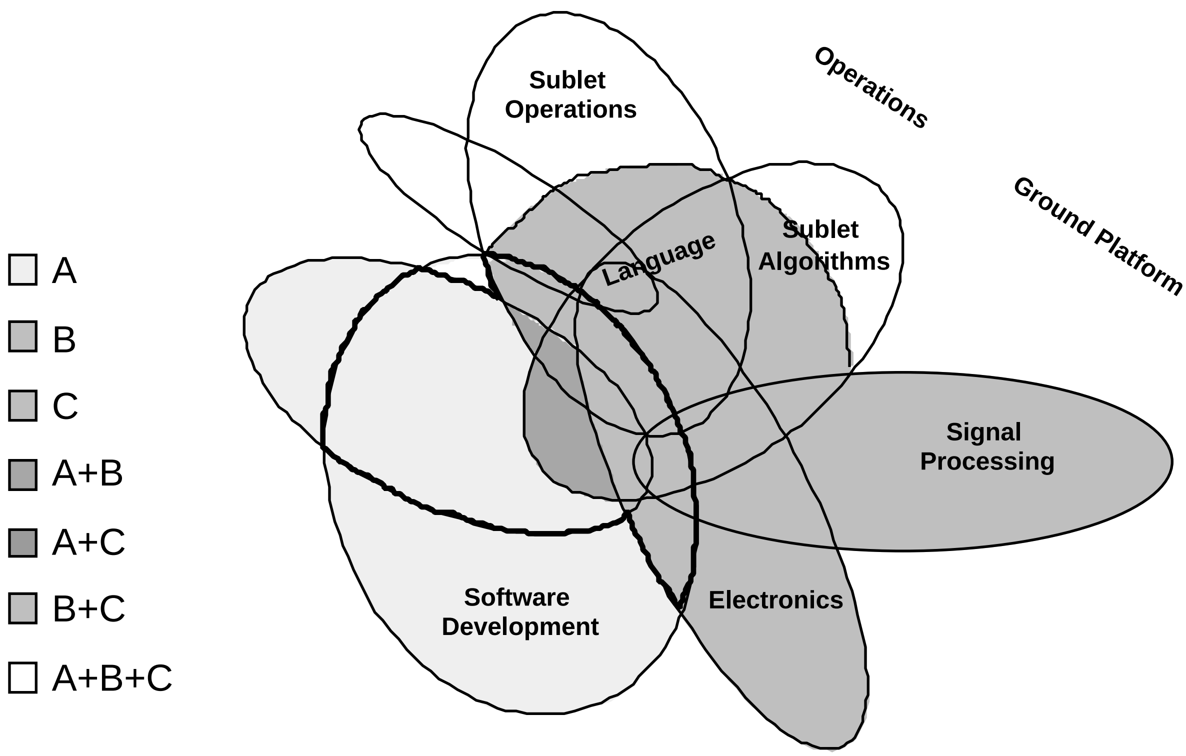

Diagram 5: Sublet Software Development Team

Human Resource Management Implications

While many companies are struggling to overlay an IPD matrix structure onto a traditional functional organization, TDS chose to make the bold move of essentially eliminating functional groups. The adverb essentially was added to the above sentence because the executives continued to provide functional leadership in staffing and budgetary decisions, as well as assuring that functional integrity was maintained within the product teams.

An organizational change to horizontal teams provides a powerful stimulus to break the functional isolationist mind-set which hinders the IPD process. Such a move, however, raises concerns as to the long-term maintenance of strategic competencies. In the short-term, the depth of functional expertise within the workforce provides a “functional conscience.” To insure that critical functional disciplines are retained over the long haul, organizations must develop a human resource management system which provides the appropriate balance between short-term product related needs and long-term strategic business and employee development goals. This case study highlights many of the key HRM elements necessary to make such a move.

Organizational Change Process – The TDS change process began with a top executive championing the effort. McCard then sanctioned a task force to develop a set of organizational principles as a basis for the division’s organizational restructuring process. The task force built upon both internal (TDS’s own history) and external learning; the latter included an extensive search of the literature and practice within industry in general. The principles the task force developed provided both guidance for the subsequent organizational structure and a cornerstone for communications to the entire workforce relative to the new organization .

Skills Register – TDS recognized the need to identify and provide a mechanism to maintain necessary skills and expertise. As they discovered, however, the identification process is extremely difficult because of the dynamic nature of IPD knowledge. IPD knowledge builds upon itself, and a significant portion of it has a relatively short shelf life. Often, shortly after a new expertise has been developed, it becomes obsolete. As a result, developing a skills register similar to that developed by TDS requires constant and extensive administration.

Furthermore, as the knowledge maps of the WAM sensor systems product team highlighted, the skills register should identify overlapping or integration skills. To a certain extent, an “entry level” proficiency rating in TDS’s skills register was used as a proxy for integration skills but it lacks specificity relative to specific entry level skills (both technical and team related) needed by individual product teams. In TDS’s case, this specificity was provided by input from the executives and other technical experts.

Because of the time and associated overhead costs involved in developing a skills register, TDS management chose to develop its data base through a voluntary self-assessment survey and to have the survey forms completed outside the normal workday. This had at least two shortcomings. One, some employees chose not to complete the survey. In an downsizing environment, some employees might have been concerned that their input would be used against them in layoff decisions. Two, because there was little opportunity for managers to personally discuss the survey format and instructions with individuals, there were significant inconsistencies in the interpretation of proficiency ratings and individual capability and skill categories. Furthermore, there was no opportunity to provide real-time feedback to individuals as to whether their team leaders agreed with their self-assessments.

Team Member Selection – The primary reason TDS developed their skills register was to aid in the matching of individual talents with team needs. The skills register provides a quick reference point to identify whether or not needed skills reside within the organization. TDS ultimately relied, however, on the knowledge of their executives to make staffing decisions in an effort to get the right mix of overlapping skills within a team. It appears that the organization was fairly successful in team assignments, as evidenced by one team member’s comments in an August 1993 employee’s newsletter,

> An excellent thing (about my team) is that all the people have just the right amount of overlap. In other words, I know enough about electrical engineering that I can interact with (team member). Similarly I know enough about control theory so I can talk to (another team member). This overlapping exists between everyone on the team. As a result, team communication and technical progress have been going very well.

If TDS, or any other organization, were to put greater reliance on a skills register for staffing decisions, the register would have be continually updated and have the artificial intelligence capability to make managerial tradeoffs as to both assignment of limited resources needed by multiple teams and development assignments to broaden individual team member expertise. Assuming such a register were possible, team needs would also have to be quantified. Even if the register was considered to be totally comprehensive at any one point in time, executive input might still be needed to fill in gaps in knowledge evolution between register updates.

Ideally, core skill needs should be identified up-front to enable the formation of a complete team from the start. This would allow the team to rapidly go through the team formation process (i.e., group dynamics and team building). If new members are continually being added, team maturation will be delayed. Furthermore, research has shown that continuity of team members throughout the entire product development cycle improves the IPD process relative to overall time and cost (Womack et al., 1990; Clark & Fujimoto, 1991; Iansiti, 1993).

Training and Development – The skills register provides one reference point to identify training and development needs. But as the knowledge map of the WAM sensor systems team showed, one of the critical areas for team member development is in the area of integration. This is needed not only in technical areas, but also in understanding business and finance related issues the team must address. Furthermore, teams need training in how to be a team, i.e., group dynamics, etc. To address this, TDS initiated a team formation and kickoff process which consisted of a one-day training session on team building followed by two weeks of intensive program definition and planning activities. One of the first steps in the team building training was for each team member to describe both his or her capabilities and what he or she believed their primary role on the team would be. As one team member noted in an August 1993 employee's newsletter,

> Everyone ended up understanding his own and other team members' responsibilities and capabilities. More importantly, as a team we learned what we don't know and recognized the need to expand team capability through training or enlistment of outside help.

Continual training will also be needed to not only develop new competencies, but to retain existing ones. Without conscious effort to maintain theoretical knowledge, there is a tendency for theoretical knowledge to be displaced by application over time.

Career Paths – With the elimination of functional hierarchies, traditional career paths have vanished. Furthermore, narrow expertise in one function is no longer desired. To be an effective integrator requires deep knowledge of and experience in one field, plus basic understanding of several adjacent fields. “Inverted T-shaped “ knowledge bases (Iansiti, 1 993; Klein, 1 993) and, hence, careers are now required. Job rotation through several disciplines early in one’s career may become more of a norm, similar to that found in Japan (Womack, et al., 1990).

Continuity within IPD teams may require individuals to start with the product from inception through first build. This will mean exposure to fewer products, but an opportunity to broaden one’s skills in multiple stages of product development. Funding to support such continuity appears to be impediment for DOD contractors in this regard. At the very least, effort should be made to shift engineers and scientists to related next generation project work to enhance continuity of knowledge within a product family (Iansiti, 1993).

Compensation/Rewards – TDS has been developing a pay for knowledge system similar to that found in many team-based manufacturing operations. The plan for 1994 is to have a skill based pay review of each TDS employee on the employee’s company anniversary date. The reviews will include inputs from the employees, their team leader and their core process owner.

Among the issues to be determined is whether the base pay should be dependent on acquired or applied knowledge. Generally speaking, conventional wisdom supports paying only for applied knowledge. If so, should the base be reduced when particular knowledge or expertise was no longer needed? This becomes an issue for both knowledge obsolescence and retaining continuity of team membership throughout the development process. Weighing the relative value of different skills and expertise is also an issue, particularly relative to individual projects.

In the IPD arena, by the time organizations are able to define and value all of the needed skills and design the requisite administrative system to support the new pay structure, many of the skill blocks become obsolete. Due to the short shelf life of highly technical IPD knowledge, some organizations have chosen to merely give a onetime bonus to encourage team members to acquire new skills.

Performance Evaluation – When TDS reorganized into teams, management recognized the incompatibility of its individual performance appraisal (PA) system with the new structure. As a result, they suspended the use of individual PAs until a team appraisal system was developed. The changes planned for the VPP, including the peer appraisal process, were designed to provide a balance between individual and team performance evaluations.

Team Leadership – Team leaders at TDS were as varied as the teams they led. The WAM sensor systems team leader acted as a “producing manager” (Lorsch & Mathias, 1987), spending much of his time working directly on the product. He acted as a facilitator initiating discussion and seeking input rather than making decisions himself. When meeting with executives or core process owners, he acted as a representative of his team instead of a manager.

One of the process team managers observed during the case study spent much of his time coordinating activities for his the team, rather than doing any direct work in the laboratory. Possibly due to the nature of the process team, the fact that he played more of a traditional managerial role provided a greater sense of there being a “home base” for his team members, many of who were co-located in product teams.

TDS’s ultimate objective is to move toward self-directed teams. Once teams mature, team leaders will become less and less involved in direct activities of the team and provide more of a facilitation role (Klein & Posey, 1990; Fisher, 1993). Strong leadership, however, will continue to play a critical role throughout the organization. Just as McCard was the organizational architect for the restructuring process, team leaders will guide to activities of teams throughout TDS.

Lessons Learned

A skeptic might read this case and argue that TDS's organization is merely a rearrangement or new twist to the traditional matrix concept. Indeed, there are still process teams that service multiple product teams and a small core of technical assets who are shared experts. What is different, however, was TDS's attempt to minimize overlapping accountabilities and responsibilities.

Was the reorganization worth the cost? Although it is impossible to attribute TDS's success solely to the organizational restructuring, TDS surpassed every one of its financial metrics in 1993. Although sales declined by 15% and the workforce declined from 2200 to 1350 over a period of 18 months, profits, cash and ROI increased during 1993. In addition, investment was cut in half. Teams also exceeded management's expectations by 131 %.

TDS management believes that revolutionary, as opposed to evolutionary, change was needed to change the division's culture. There was a shock value associated with destroying TDS's traditional organization which aided in assuring that functional groups did not undermine the new structure. If the functional groups had continued to exist, many team members would have remained psychologically hooked to their career anchors (Schein, 1977). In many respects, it will be easier for TDS to now make incremental changes.

One of the most impressive aspects of TDS's change process was TDS's holistic approach to the new organization. Although they continue to struggle with several aspects, they recognized the need to redesign their entire human resource management system, including compensation, reward and performance appraisals systems. They also recognized the need to identify and track critical skills and competencies as functional experts were dispersed throughout the organization. Lastly, they acknowledge that the journey has only begun and that continual review and adjustments will be necessary to meet the very changing demands of the industry.

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Appendix A: Product Team Activities Survey

Purpose of Survey

To gain an understanding of the role of team concepts in integrating skills and expertise of all kinds into activities and decisions associated with the product development process.

Column Heading Definitions

"Activity/Decision" - The particular activities, tasks and decisions you are involved in during a typical week. This include, but are not limited to, the following categories:

- operational (e.g., wiring a board, writing software code)
- analytic (e.g., troubleshooting a board, designing algorithms or code)
- integrative (e.g., merging blocks of code, design for manufacturability)
- business (e.g., time accounting, cost analysis and control)
- organizational (e.g., attending meetings, reading or writing memos)

"Who's Involved" – The people who interact with you on a particular task, activity or decision, and the team each person is a member of.

"Type of Involvement" – The way those involved interact with you. Again, this includes, but is not limited to:

- relationship (e.g., your co-worker, advisor, supervisor, advisee, customer)
- function of interaction (e.g., technical advice, purchase authorization)
- depth of interaction/level of detail known to those involved

"Skills/Expertise" – The knowledge required to complete the particular task, activity or decision. A skill is a tool used to complete a task, such as the working knowledge of "Quick-C." Expertise is specialized knowledge, such as "real-time acoustic signal processing algorithm design."

In addition to a good description of what skills and expertise were required for a particular task, activity or decision, it would be helpful to know where, when and how the knowledge was acquired.

Activity/Decision	Who's Involved	Type of Involvement	Skills/Expertise