Interdisciplinary Competence: The Key to Exceptional Project Performance

Abstract: This paper describes the benefits for integrating knowledge across project teams. Research in interdisciplinary demonstrates that better integration of knowledge is achieved through individuals attaining cross disciplinary learning. Integrated teams of interdisciplinary members achieve better problem solving through leveraging common knowledge. This common knowledge or common ground is the overlap between disciplines. Interdisciplinary project managers facilitate problem resolution across the team; leveraging common ground to produce better integration of team knowledge and ideas.

Results, from academic institutions and a 3M study, support the development of depth and breadth in disciplines to achieve exceptional performance. Traditional individual development focus on specialists and generalists. Academia has established interdisciplinary curriculums and research centers to facilitate greater advances of knowledge and technology. For complex projects, interdisciplinary project managers facilitate the integration of knowledge across the team. Developing interdisciplinary project managers require changes to organizational personnel practices to leverage the combination of depth and breadth for key positions.

As stated by John Sterman of the Sloan School of Management at Massachusetts Institute of Technology (MIT), "large scale projects belong to the class of complex dynamic systems…these systems are extremely complex, consisting of multiple interdependent components; are highly dynamic; involve multiple feedback processes; involve nonlinear relationships; and involve both hard and soft data (Sterman, 5).

Complex problems require balancing multiple conflicting and competing objectives and constraints to determine a solution. A problem limited to a single disciplinary field is solvable by experts of that disciplinary field. Complex problems cross disciplinary fields requiring multiple disciplines for a solution. Integrated Product Teams (IPTs) are multidisciplinary, comprising specialists from several functional areas; however, an IPT is challenged fusing knowledge across disciplines. Solving complex problems requires different thinking than solving simple problems.

An interdisciplinary perspective bridges knowledge between disciplines to identify solutions to complex problems. Successful teams integrate multiple disciplines to frame a problem, agree on a methodological approach, and analyze data using collaboration (Stock, 7). Exceptional teams better fuse the integration of knowledge, seeing connections and intersections that a single discipline would not. An interdisciplinary project manager facilitates the knowledge across team members, establishing an environment for good problem solving. Greater integration of disciplinary knowledge creates more effective critical thinking and innovative ideas.

Typically, the pursuit of further knowledge and exploration deals with depth within one field to gain further understanding. The concept of interdisciplinary studies requires not only depth but breadth across more than one discipline to understand the integration of knowledge between the studied disciplines.

Individuals educated in multiple disciplines are better able to design and apply a process based on conditions and constraints. This produces flexibility in thinking that challenges trained specialists; competence bias inhibits one to think past that single view. Common ground is the linkage between the disciplines creating insight and ability to gain multiple perspectives. Using a multidisciplinary approach through a team of disciplinary or functional specialists does not achieve integration or synthesis of knowledge due to lack of common ground.

Teams of specialists produce a multidisciplinary approach, viewing a problem from their own discipline and recommending solutions based on their area of expertise (figure 1). A project manager either selects one solution or needs to merge the multiple solutions into a single fused solution. This requires an interdisciplinary approach and accompanying knowledge of the various functional areas of expertise to develop a single, comprehensive solution. This fused solution is different from any single, functional solution.
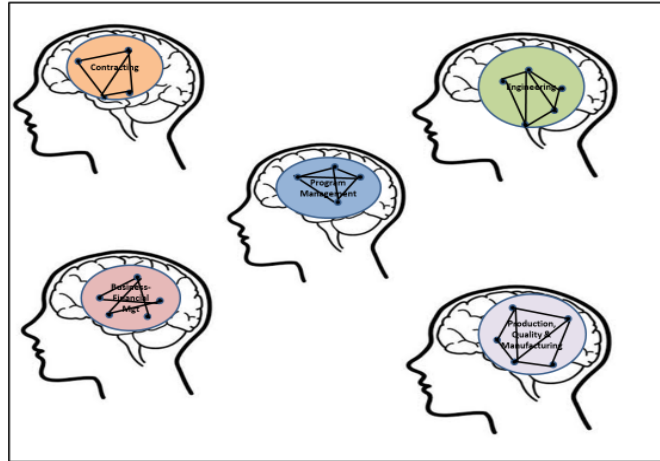
Figure 1. Multi-disciplinary Knowledge of a Team

Jay Forrester of MIT developed the system dynamic concept as a theory for understanding complex systems. He initially developed the tool in the engineering domain but then applied it to the business world. The system dynamics paradigm concludes results of decisions are disappointing because important casual relationships are overlooked or misread usually by assuming a linear or unidirectional relationship versus a nonlinear and multidirectional relationship (Martin, 152). Applying a systems perspective from engineering to business operations is an interdisciplinary approach. Specialist dominated organizations often simplify problems to linear, unidirectional casual relationships, even if the problem is more complex and multidirectional. Simplifying a problem can lead to solving the wrong problem. Interdisciplinary research laboratories, such as the Rockefeller University, recognize the need to solve complex problems with integrated, complex solutions. The university is recognized for more major discoveries in biomedicine than anywhere else in the world. The success is attributed to a laboratory environment deemed 'without walls' to promote cross-knowledge utilization of scientists on research projects.

The need to acquire breadth even when pursuing advanced degrees is recognized in the recommendations for a new vision for academic institutions. Although the findings focus on academic application for universities, institutes, and laboratories, they are easily transferable to government organizations and industry for solving problems and improving effectiveness in managing projects or programs. A workforce skilled in single disciplines challenges integration of complex technology development. An interdisciplinary workforce positions enhanced technology development through individual knowledge integration and then team knowledge integration. Common vocabulary can enhance understanding across team members.

> "A matrix structure in a university might include many joint faculty appointments and PhDs granted in more than one department which would enable participants to address cross-cutting questions more easily. It might create numerous interdisciplinary courses for undergraduates, provide mentors who bridge the pertinent disciplines, and equally important, offer faculty numerous opportunities for continuing education whereby they could add both depth and breadth of knowledge throughout their careers" (National Academy of Science, 172-173).

In the innovation process, existing brain connections (neurons) significantly change to cross a

wider number of areas of the brain dealing with different types of knowledge and problems to assimilate very different concepts and challenge long held assumptions. The strengthening of neurons in the brain creates competence bias and limits problem solving. Competence bias limits recognizing multiple solutions, reverting to one's current knowledge base without pursuing further information.

Innovation relies on an individual's expertise to generate new knowledge or create new ideas through combining ideas to create innovative applications. The researchers' state:

> "Even though many inventions are created when individuals work in teams, studies allude to the observation that individuals are effective in combining existing knowledge to generate new knowledge and innovations. Innovative ideas and insights first occur to individuals, before such ideas are subsequently shared at the group levels and institutionalized at the organizational level. Fundamentally, this highlights that individuals are the basic unit in which knowledge integration and knowledge creation takes place, regardless of whether individuals work alone or in teams" (Boh, 349).

If innovative ideas are not created at the unit level, they are not created at the team level. A study conducted on how inventors' breadth and depth of expertise influence innovation at 3M Corporation exceeded previous research focused on a single indicator, technical success achieved by the inventor. The 3M study examined three indicators: (1) the number of inventions generated, (2) the extent to which the inventor has a significant impact on the technical domain, and the inventor's career success, in terms of commercial value they have brought by converting their inventions into products that generate sales for commercial organizations (Boh, 349).

The study concluded that generalists (breadth) create many inventions but are not technically influential; specialists (depth) create fewer inventions but are technically influential. The combination of breadth and depth (polymath) of expertise create the most valuable inventors based on their record for effectively converting inventions into commercially successful products. In other words, the polymath earned the most money for 3M Corporation by producing the most marketable inventions.

A specialist is defined as one who achieves great depth in knowledge through learning and experience. The study concluded that specialists acquire ability for detail and accurate analysis of a problem leading to solutions for difficult technical problems in their area of expertise. Specialists also make difficult trade-offs and through their depth of knowledge can better predict what will go wrong. They create groundbreaking innovations through persistence of exploring deeper into an area.

Generalists have knowledge in a broad range of areas but do not acquire expertise in any one area. Generalists tend to enjoy new work and become bored when confined to one area; this inhibits their ability to develop the specialist's depth of analysis. Generalists focus on application of technologies into useful products and integration of multiple technologies into a product, creating innovation through a broader focus.

Polymaths acquired interdisciplinary competence through obtaining significant depth and breadth, first becoming an expert in one area and then expanding their expertise into other areas. One polymath inventor at 3M Corporation described the benefits of both: "his depth of expertise plays a key role in identifying the technical contributions of an idea, while he draws upon a breadth of expertise to evaluate the potential ways the invention can impact different industries" (Boh, 355). By balancing the combination of depth and breadth, polymath inventors become astute at applying, integrating, and recombining technology of their domain across other

technologies and applications. Generalist inventors focus on applying a developed technology in other applications but lack the depth to develop the technology. Generalists acquire an interdisciplinary perspective but without depth of knowledge are challenged to exploit the overlap between disciplines. Specialists develop the technology but lack breadth to apply in various applications.

How are polymaths developed? Acquiring depth probably precedes acquiring breadth. Once depth is acquired, the polymath can use that "learning how to be an expert" to develop depth in other areas faster. First acquire the ability to go deep and then apply that ability to go broad. Once the path of breadth is established without acquiring depth first, depth is probably never attained.

The study concluded that organizations need specialists, generalists, and polymaths but "both breadth and depth of expertise are required to effectively convert inventions into commercially successful products that bring sales and value to the organization. The polymaths contributed not only by generating inventions but applying those inventions widely to multiple parts of the organization, integrating with multiple technologies, thus becoming the most valued scientists of 3M" (Boh, 364).

This combination is created through starting careers developing significant depth in one area. Over time, significant knowledge and experience outside that domain is acquired. By leveraging an understanding for how to become an expert, one develops an expertise more quickly in other areas. A polymath develops an interdisciplinary perspective through attaining depth and breadth across multiple disciplines, leveraging the knowledge interface between functional areas to develop the interdisciplinary perspective faster. For example, Jay Forrester of MIT acquired expertise in system dynamics for engineering and then applied the concept of system dynamics to business and management.

For teams to be effective, team members need common ground to develop fused ideas. Each discipline develops greater depth of their discipline through linkages of the knowledge nodes. The results of the team will likely evaluate solutions based on a single, functional approach when little common ground (linkages) exists between the functions (figure 2).
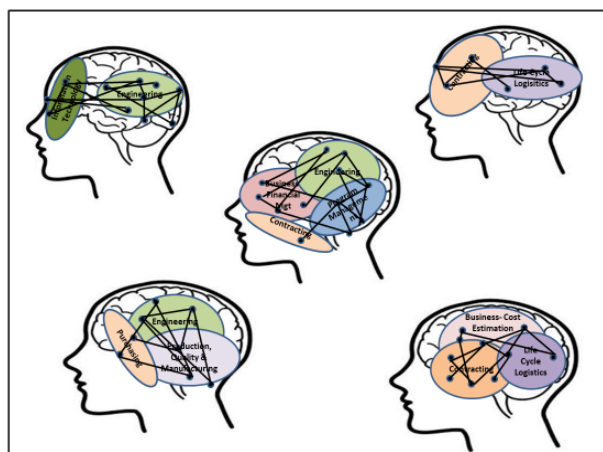

Figure 2. Lack of Linkage between Integrated Functions

Typically, project managers may lack interdisciplinary knowledge, selecting the one disciplinary solution that appears to have the most advantages with fewer disadvantages for other

areas. This is not an integrated solution. An integrated project manager has an interdisciplinary background with knowledge and experience across pertinent disciplinary areas facilitating knowledge integration through a common ground for the team. The greater the complexity of the project, the greater the need for an integrated project manager.

The common ground between the project manager and a team member can share knowledge from one team member to another team member, basically creating a network transfer of knowledge through common ground (figure 3). Common vocabulary is the most basic aspect of common ground. Interdisciplinary project managers develop expertise in a discipline and then build upon that expertise acquiring competence in other areas. This capability then facilitates knowledge across the team members. Project management career path development should cross multiple disciplinary areas while ensuring depth of knowledge within those disciplines. Experience through challenging assignments strengthens the learning and produces adaptable, resilient problem solvers.
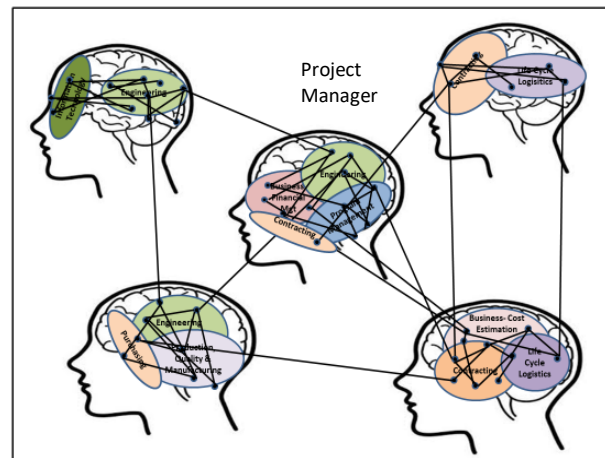

Figure 3. Knowledge Integration Maximized through Project Manager

An interdisciplinary team merges knowledge across multiple disciplines; each team member's knowledge crosses at least two disciplines (figure 3). For solving complex problems, greater insight is needed through crossing disciplines. Having the workforce develop an initial primary field establishes expertise and then secondary field certifications develop breadth. Integrated interdisciplinary teams leverage the connections of knowledge and provide a means for "seeing the space between nodes of knowledge". Common ground connects two different areas sharing modeling or statistical tools; analytical tools should complement training curriculums and position assignments. Interdisciplinary individuals resolve complex problems across multiple disciplines through the internal fusion of knowledge and understanding.

In summary, individuals create ideas. Teams improve upon those ideas. Interdisciplinary teams are more capable to synthesize ideas by leveraging common ground. Interdisciplinary project managers facilitate better team knowledge integration and therefore develop comprehensive ideas or problem resolutions.

References

1. Boh, Wai Fong, Roberto Evaristo, and Andrew Ouderkirk. *Balancing breadth and depth of expertise for innovation: A 3M story*. Elsevier Research Policy 43. 2014. http://www.elsevier.com/locate/respol.

2. Martin, Roger. <u>The Opposable Mind: Winning through Integrative Thinking</u>. Harvard Business School Publishing, Boston, MA 2009.

3. Academy of Sciences, National Academy of Engineering, and Institute of Medicine of the National Academies. *Facilitating Interdisciplinary Research*. The National Academies Press. Washington, DC. 2005.

4. Sterman, John. *System Dynamics Modeling for Project Management*. Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA 1994.

5. Stock, Paul and Rob J.F. Burton. *Defining Terms for Integrated (Multi-Inter-Trans-Disciplinary) Sustainability Research*. Sustainability. ISSN 2071-1050. July 26, 2011. http://mdpi.com/journal/sustainability .