Center for Patterns & Systems Engineering

School of Systems & Enterprises

STEVENS Institute of Technology

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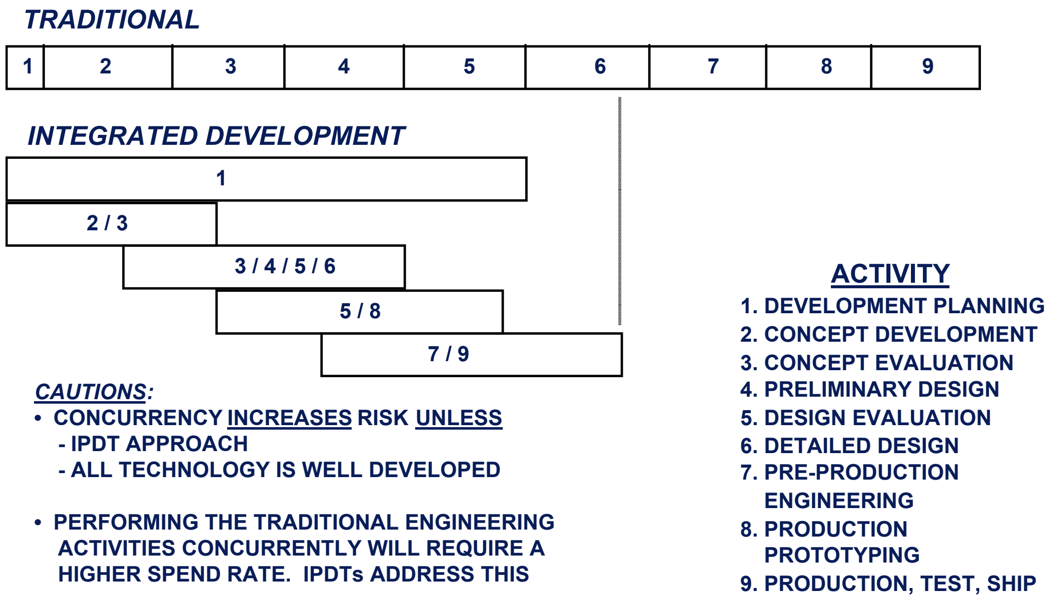
Pattern Name	Multi-disciplinary Teams
Aliases	Concurrent Engineering, Integrated Product (Development) Teams
Keywords	SE 'best practices' IPDT,
Problem Context	Modern systems are more complex and of greater scope than was possible to realize as recently as a century ago. Such systems are generally designed and realized through projects. Projects are generally organized into small groups possessing specialized talents that allow each group to accomplish a specific task. Complex systems require that the results of these efforts are integrated into a final solution. This requires timely and precise communication between the groups.
Problem Description	Groups of people working on a complex modern system design must be technological experts but often lack the skills to communicate effectively with other specialists in order to create a workable solution. Technology experts generally lack the authority needed to make important decisions throughout the life of a project.
Forces	Groups of people who must work closely together are often confronted with the following challenges: • The system design process is punctuated by critical decisions that require accurate and timely information, • Confusion about roles and responsibilities of the participants, both at the individual and group level, • Confusion about responsibility for tasks that lie in the interfaces with other groups, • Communication with stakeholders is complicated by domain-specific language, • Inter-team communication is hampered by the variety of discipline-specific languages, and • Barriers inherent in organizational structures inhibit information exchange.

Pattern Solution	Establish multi-disciplinary teams (MDT), often implemented as integrated product development teams (IPDT), to perform concurrent engineering. Create a responsibility assignment matrix that maps the tasks identified in the Work Breakdown Structure onto an organization's project teaming chart to avoid duplication of efforts
Sketch	See sketch from INCOSE Systems Engineering Handbook, v2a, page 74
Interfaces	Discussion of the critical interfaces or information flows necessary in implementing the pattern
Resulting Context	When Systems Engineering is done first, it is possible to design out unnecessary complexity. MDTs are able to resolve project issues quickly through direct communication between team members. Such intra-team communication shortens the decision-making cycle and is more likely to result in improved decisions because the multi-disciplinary perspectives are captured early in the process. Studies have shown that group decisions are often "riskier" resulting in the potential for greater innovation. In a multi-disciplinary team, each member comes from a discipline with its own perspective and focuses on representing that viewpoint. An integrated team is generally multi-disciplinary but each member is expected to establish the necessary relationships with the other members and to confront the team with challenging ideas with the focus on the final result. As a member of the MDT, the informed customer becomes a partner in a structured and disciplined process that enables the team to meet stakeholder expectations.
Example	An example of how the pattern may be applied
Pattern Rationale	The rationale revolves around two elements, organizational structure and communication skills. One limitation of this solution is that while facilitated communication is a necessary factor for good decision-making and good design, it is not sufficient to ensure either. Related patterns that discuss additional factors should be referenced by this pattern as the literature matures. Large organizations must cope with large numbers of people and concurrent activities. Bureaucracy is common in these organizations to preserve order. However, the benefits of aligning groups of people such that they share a common focus (usually determined by technological boundaries) also can have an adverse affect on the goals of an integrated program. Specialization leads to over- or under-design at the expense of considerations about the relevance of the design to achieve a given purpose. When design tasks are assigned to specialized groups, lateral communication is either non-existent or very difficult. Too often, systems engineering is practiced as a form of crisis management to perform after-the-fact integration of separate components to make them "play together." The barriers that inhibit close "day-to-day" working relationships also inhibit the transfer of essential information for decision-making. The influence of political-economic-technical-human factors plague decision-making in bureaucratic environments thereby jeopardizing the resulting design. Chase continues (5, p.22), the organization of a system project should provide opportunity for all disciplinary specialists to work together continuously on a face-to-face basis and, most importantly, to acquire the systems viewpoint and understanding of the role that their specific knowledge can provide in deriving a particular system design.

	Recognition of the value of this type of team dates back to the mid-sixties (4, p.37); "The generation of a balanced design requires that each major design decision be based on proper consideration of system variables… This necessitates the closest coordination of select personnel skilled in SE who work as a homogenous system design team." Chase also says that in organizing for success it is critical to facilitate communications and "system designs are dependent upon the effective integration of multidisciplinary efforts." He further advocates mapping the tasks of the milestone schedule to the WBS and identifying the lines of communication among tasks in terms of interdependencies and mutual constraints to reveal that different phases of the lifecycle call for different tasks and different personnel skills. Properly used, this allows management to acquire and properly utilize the proper combination of specialist and generalist skills. A project avoids "bureaucratization" of the design approach by streamlining the organization and integrating the various specialist backgrounds into common system-oriented task groups with loyalties directed toward the systems design effort. In (6, p.177) the authors refer to cross-functional processes as the *horizontal system* within an organization. Management looking for performance improvements is advised to focus on the effectiveness and efficiency of the horizontal organization. This approach recognizes individuals and groups who understand the "big picture" and the business of other functional areas with which they need to collaborate. Interactions focus on win-win decision-making. Regarding the importance of communications (5, p.14); "Only if clear communications among the varied specialized efforts is established can there be an integrated coherent program effort, such as is required to design and develop a system composed of complex subsystems that must function effectively together as a unified entity."
Known Uses	J. Parker, 1989, *"Peacekeeper IFSS – A TQM success story,"* National TQM Symposium 1989, DC: AIAA. Parker writes of Martin Marietta's use of "tiger teams" in crisis situations. These are cross-functional teams that dropped traditional differences, focused on the task at hand and were able to achieve remarkable innovations very quickly. The challenge for MM was to use this approach in a non-crisis situation. Parker is very clear that a major contributor to the success of the project was the creation of opportunities for people from different disciplines to work together face-to-face to achieve dramatic reductions in cycle time.
Related Patterns	Other patterns what may work in conjunction or in association with this pattern
References	1. Martin, James N. 2000. Systems Engineering Guidebook: a process for developing systems and products. CRC Press LLC. 2. Forsberg, Kevin et al. 2000. Visualizing Project Management: A model for business and technical success (2.ed). John Wiley & Sons, Inc. 3. Blanchard, Benjamin S. and Wolter J. Fabrycky. 1997. Systems Engineering and Analysis, 3.ed. NJ: Prentice Hall.

	4. Chestnut, Harold. 1967. Systems Engineering Methods. John Wiley & Sons, Inc. 5. Chase, Wilton P. 1974. Management of Systems Engineering. John Wiley & Sons, Inc. 6. Rummler, Geary A. and Alan P. Brache. 1995. Improving Performance: How to manage the white space on the organization chart. San Francisco, CA: Jossey-Bass Inc.
Authors	Cecilia Haskins; with thanks to James O. Coplien for his review of an earlier version of this pattern, and his feedback. Previously published in paper for IS2005.

Sketch:



From INCOSE Systems Engineering Handbook, v2a, page 74