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Technical and institutional factors in the emergence of project management

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Abstract

This paper explores the fundamental question of why the practice and discipline of project management emerged during the 1940s through the 1960s in the United States. Although projects have been around for millennia, not until the middle of the 20th century in the U.S. military–industrial–academic complex did project management become formalized in institutional processes and as an academic discipline. The paper argues that technical complexity and novelty were the primary factors driving project management and its engineering counterpart systems engineering, as a new organizational form. Institutional factors such as the need for legal separation between government and industry created important secondary effects that drove the particular forms in which project management evolved. This paper uses examples from large scale, complex projects of the 1940s through 1960s in the aerospace and computing industries to tease out the fundamental technical and institutional factors that led to the emergence of project management in these two key American industries during this period.

Keywords: History; Systems analysis; Configuration management; Systems engineering; Systems integration; Weapon system; Intercontinental ballistic missile; Polaris; SAGE; Air defense; Von Braun; Schriever; Ramo-Wooldridge; MITRE; Phased planning; Lincoln Laboratory; Atomic bomb; V-2; Matrix management; Complexity

1. Introduction

Recent renewed interest in history among project management (PM) researchers has led to calls to: move beyond the single case study method to address methods and ideas between and across projects (Packendorff, 1995), to understand the evolution of project methods over time and their changing contexts (Engwall, 2003), to understand the many kinds of projects and their behaviors, functions, and measures of success (Söderlund, 2004), call attention to early PM's flexibility and propensity to experiment (Lenfle and Loch, 2010). All of these issues, along with the seven schools of PM research identified in Söderlund (2011) require deeper historical understanding than can be gained by normative assessments of single projects.

Viewed historically, PM is a major step in the evolution of how managers gained (or attempted to gain) control of organizations, technologies, and workers. Management as a career path developed with the creation of railways in the 19th century in the United States (Chandler, 1977). To manage large-scale, distributed railroad organizations, managers borrowed Army methods in developing "systematic management", which they used to control schedules, finances, and cargo. Upper management used systematic management to control mid-level managers and office workers (Yates, 1989). At the turn of the century, Frederick Winslow Taylor developed "scientific management", which enabled managers, allied with engineers, to control factory operations and workers (Kanigel, 1998). These methods made the Ford assembly line possible (Nelson, 1992). Taylorist methods morphed into the Quality Control movement in Japan and then into Total Quality Management, which propagated around the world after World War II (Tsutsui, 1998).

Project Management came into being in the 1940s–60s in the United States (U.S.) military–industrial–academic complex (Morris, 1994), in conjunction with operations research and systems engineering (Johnson, 1997). Within this context, PM became the primary managerial technique to develop complex

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new products and technologies. We will see that project management formed as a response to difficult technical and organizational problems with complex military projects. This paper will demonstrate that project management is an evolving technique of organizational problem solving, which was created in a specific time, place, and culture to resolve specific problems.

2. Precursors: World War II

World War II was a crucible in which scientifically sophisticated technologies were rushed from research to development to production to operations. Several particularly complex technologies and operations required new methods of analysis, coordination, and organization. These included radar, the German V-2 ballistic missile, the American B-29 bomber, and the atomic bomb.

2.1. Operations research to Project RAND

Operations research was initially created in the run-up to World War II in Great Britain to help create an effective air defense system from a network of radar stations linked to fighter squadrons. Radar technology enabled detection of aircraft by reflected radio signals. German bombing raids on London during World War I made the problem particularly urgent. Scientists were crucial in determining how to link radar detection of bombers to the direction of fighters to intercept them. Operations research's reputation was made when the new radar-based air defense system proved itself as a key factor in British victory in the Battle of Britain (Buderi, 1996). Soon British operations research scientists were tackling problems of anti-aircraft gunnery, submarine detection, bomber navigation, and a host of other pressing issues.

By 1943 American scientists were using operations research to study critical problems such as antisubmarine warfare, aerial operations to mine Japanese harbors, and bomber formations to ensure maximum protection against enemy fighters (Rau, 2000). In early 1946, the Commander of the Army Air Forces funded Douglas Aircraft Corporation's Project RAND to study intercontinental warfare. As its interactions with Air Force leaders to provide scientific expertise created potential conflicts of interest for Douglas in contract bids, Douglas executives spun it off into the non-profit RAND Corporation. RAND Corporation became an influential force in the development of "systems approaches" over the next two decades (Smith, 1966). As we will see, for project management, operations research is of significance because when applied to the study of technical feasibility, it became "systems analysis", the first step in deciding whether to create a military project. This began to link proto-project management with military, technically advanced projects.

2.2. Systems integration: the B-29 and Mark 56 Gun Director

One of the key "systems approaches" to organize highly technical projects that became essential in the early Cold War was "systems integration". It formed in projects to develop complex aircraft and radar-directed anti-aircraft artillery. To understand the linkage between the technical problem-solving and organizational methods that became project management, one must first understand the pre-war process of aircraft design, testing, and production.

Specialized organizations for aircraft development did not exist in the United States until the 1930s, leaving aviation initially dominated by individual aviators and their companies. The Army Air Corps procurement process started with the release of specifications for industry. Contractors built a prototype known as an "X-Model", which the Air Corps tested by flying it. Test flights resulted in change recommendations, which were incorporated into a "Y-Model" prototype, whose design also addressed production considerations. After further flight tests, the contractor released production drawings. The Air Corps issued these for production bids, and the winning contractor then built the specified number of aircraft. The Air Corps then added weapons, radios, and other gear, and released the resulting aircraft into the field. To manage this process, the Air Corps typically assigned a single project officer with a small staff.

This process changed significantly during the Second World War, as the Air Corps became the Army Air Forces. As the military hurried to put aircraft immediately into production, Congress allowed procurement officers write letters of intent to contractors to rush aircraft into production immediately, with cost negotiations deferred and costs reimbursed. Consequently, the Army Air Forces procurement staff expanded dramatically. As the Air Forces found design problems in testing and combat, aircraft were shipped from production lines to modification centers, which installed the latest changes. After this, the government separately installed weapons, navigation systems, and communications equipment.

These procedures did not suffice for complex aircraft like the B-29 and the P-61. For these aircraft, weapons were directly integrated into the airframe, with (analog) computer-controlled gunnery and a pressurized interior. Project officers organized committees to develop and integrate the airframe, electronics, and armaments together into an entire "weapon system" (Johnson, 2002b).

Systems integration also became an issue in the development of the US Navy's Mark 56 Gun Fire Control System, which connected radar to an analog computer that controlled the fire of its anti-aircraft gun. Institutions created problems due to the division of labor within the Navy's Bureau of Ordnance, and between the Massachusetts Institute of Technology Radiation Laboratory, the Navy, and other contractors. Ivan Getting, who headed the project for the Radiation Laboratory, believed that the Navy's difficulties with automated gun directors were due to Bureau of Ordnance's practice of dividing the work into small subcomponents, after a brief initial effort to define the system. This division of labor did not work because of the tightly coupled relationship between the radar, the gun itself, and the gun director's computers, which had to factor in the movement of the ship on which the gun was mounted, as well as the movement of enemy aircraft.

In early 1945, Getting proposed changing the Radiation Laboratory's responsibilities from its historical role of designing