

THE PRACTITIONER

A monthly newsletter of the Energy Facility Contractors Group's
Project Delivery Working Group



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Managing Design and Construction Using a Systems Engineering Approach

Many know the importance and value of DOE O 413.3B “PROGRAM AND PROJECT MANAGEMENT FOR THE ACQUISITION OF CAPITAL ASSETS”. What some may not realize is the importance of its companion guide DOE G 413.3-1 “Managing Design and Construction Using Systems Engineering”. Knowing and implementing the DOE structured approach to managing design and construction can significantly improve the departments success in completing 90% of projects across a three-year rolling average, without exceeding by more than 10%, the original cost baseline for the original approved scope at CD-2 for all capital asset projects with a TPC greater than \$50M.

This issue of the *Practitioner* will provide highlights of the systems engineered approach outlined in the DOE G 413.3-1. Note: ***“This Guide describes suggested nonmandatory approaches for meeting requirements. Guides are not requirements documents and are not construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual.”***

The goal of this Guide is to provide the Department of Energy's federal project directors (FPDs) with the knowledge, methodologies, and tools needed to meet Order 413.3 (current version) requirement that they plan, implement and complete their assigned project(s) using a Systems Engineering approach. This requirement is particularly significant because Systems Engineering is **the only specific engineering discipline imposed on the FPDs by the Department's directives**; and because it provides the FPDs with a methodology that they can use to fulfill the following other responsibilities that DOE O 413.3 imposes on them to:

- demonstrate initiative in incorporating and managing an appropriate level of risk to ensure best value for the government
- ensure that safety is fully integrated into design and construction for high-risk; high-hazard, and Hazard Category 1, 2, and 3 nuclear facilities
- ensure that design, construction, environmental, safety, security, health, and quality comply with the contract, public law, regulations, and Executive orders
- plan and implement a Quality Assurance Program for the project
- initiate development and implementation of key project documentation; and
- clearly define the roles and responsibilities of the Integrated Project Team relative to the contractor management team.

The intent of this Guide is to provide the FPDs and the Integrated Project Teams (IPTs) with a better understanding of:

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- how reports and tasks required by DOE O 413.3 can be brought together as a system,
- how the different DOE O 413.3 guides come together as a system,
- how other DOE rules and directives interface with the project development process, and
- how to use systems engineering lessons learned from past projects.

These tools, knowledge and insight can help to improve project performance by avoiding systems level integration deficiencies.

What is Systems Engineering?

A proven, disciplined approach that supports management in clearly defining the mission or problem; managing system functions and requirements; identifying and managing risk; establishing a basis for informed decision-making; and verifying products and services meet customer needs

When is Systems Engineering is utilized?

- Upon approval of mission need to analyze alternative concepts based on user requirements, risks, costs, and other constraints to arrive at a recommended alternative
- In the Project Definition Phase to integrate requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration to evolve a cost-effective, preferred solution to meet a mission need
- In the Execution Phase to balance requirements, cost, schedule, and other factors to optimize the design, cost, and capabilities that satisfy the mission need

**THE
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How is this Guide Structured?

The Guide's structure mirrors the project evolution process outlined in DOE O 413.3 (current version). Specific actions that should be taken at each step in the project evolution are addressed in separate sections in the approximate sequence in which it would be performed; however, it should be recognized that many of the actions are iterative in nature and should be undertaken in parallel and would have to be undertaken in a different sequence if an architect-engineer is utilized to develop the alternative design concepts. Issues such as verifying that products and services meet customers' needs that are integral to each step of the project evolution process are, by necessity, addressed in increments as they emerge.

Unlike the other 413-series Guides, this one begins from a higher level starting point to look at how all DOE directives (i.e., the various components that comprise DOE's management system) come together as a project evolves.

The FPD and the IPT roles and responsibilities for design and construction management are addressed with attention placed on the front-end of a project since the Department, as owner is responsible for defining the mission and the associated requirements; obtaining the human, financial, and technical

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capabilities needed to meet those requirements; and planning the project so as to deliver the greatest net value.

Sources of Information

The Guide presents acceptable methods for implementing the Systems Engineering requirements specified in DOE O 413.3 (current version) together with supplemental information about these methods including lessons learned. This information flows from other Government agencies' procedures; professional societies' presentations and publications; national and international consensus standards; texts; doctorate dissertations; and, lessons learned from independent reviews and research studies of failed or troubled projects.

The quality and quantity of the research in the field has promoted an extensive evolution of Systems Engineering in the past decade. Principles and practices that are new include attention to interdependency and uncertainty management.

ASSEMBLE AND CHARTER THE INTEGRATED PROJECT TEAM

IPT assembly and chartering is one of the first actions taken on a project because the IPT performs the bulk of the activities in the project definition phase (i.e., the phase between Critical Decision 0 and Critical Decision 1). DOE O 413 (current version) specifies four separate requirements in regard to assembly and chartering of the IPT. Specifically:

- FPDs clearly define IPT roles and responsibilities relative to the contractor management team
- The Charter specifies IPT decision making authority
- The Charter provides the IPT's operating guidance
- "Competence (shall be) commensurate with Responsibility - Personnel shall possess the experience, knowledge, skills and abilities necessary to discharge their responsibilities."
- The actions associated with these four requirements are frequently interdependent and should be considered and responded to in total.

Responsibility for assembly of the IPT and the development of the Charter depends upon whether an FPD has been appointed. The program manager or the head of the field organizations establishes the IPT and prepares the initial Charter if a permanent FPD has not been approved. These same individuals formally concur with the Charter if a permanent FPD has been approved because the bulk of the project's staffing will be taken from their organizations. IPT assignments on larger projects typically require all, or nearly all, of the IPT member's time and can last for several years. Both IPT membership and the Charter must be approved by the Secretarial Acquisition Executive or the Acquisition Executive. The Secretarial Acquisition Executive or the acquisition executive should evaluate whether the proposed staffing is adequate for the complexity and importance of the project before approving these documents.

On more complex projects, the Charter and the IPT staffing plan are likely to be modified and re-approved several times over the course of the project to accommodate membership needs and activities the IPT should perform. Updates and new requests for approval should be integrated with the Critical Decision approval process.

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PRE- CONCEPTUAL PLANNING

Pre-conceptual or up-front planning is initiated as either the final activity prior to Critical Decision 0 or the first activity immediately after Critical Decision 0 approval and is the beginning of systems engineering. This multifaceted effort entails simultaneously defining the end-product the project will deliver and how the design and construction activities will be undertaken and managed. Both efforts are tightly intertwined. The precise method of undertaking and managing the design and construction efforts depends upon the end-product. And, conversely, the end-product has to be compatible with what the designers, constructors, and management teams are actually capable of delivering successfully.

The FPD and the IPT perform the bulk of pre-conceptual planning and ensure that the two efforts are aligned through a series of iterative steps starting with capturing the project requirements and ending with determining the appropriate project development strategies.

Each of these steps is defined below together with the specific action(s) that should be taken at the completion of the step.

Capture Project Requirements

Identifying project requirements is fundamental to systems engineering and is integral to or a prerequisite for nearly all of the tasks identified in DOE O 413.3 (current version). It is impossible to develop a meaningful Risk Management Plan, Project Execution Plan, Acquisition Strategy, or the alternative design concepts needed for Critical Decision 1 approval without previously identifying the requirements associated with the project. Similarly, the probability of the architect and engineering firms' developing an acceptable design solution or the necessary depth of specifications and drawings are nil if they do not know the Department's requirements.

Project requirements are the primary means of communicating the Department's expectations to the organizational elements involved in the project. Accordingly, they should enfold all of the major aspects of the project, provide the depth of information each user needs to perform their particular role, and be available for the user at the right point in time.

Enfold All Major Aspects of the Project

Project requirements fall into two categories. **The first** is comprised of those attributes that the project is expected to demonstrate once it is completed (e.g., mission related requirements such as storage capacity and production rates, operational requirements such as mean-time-to-failure, and requirements that are adjunct to the mission but of major importance such as safety and security).

The second category is comprised of procedural requirements the deal solely with project delivery (e.g., calculation methods, reports and data to be developed and submitted at specific stages, approvals that must be received, codes and standards to meet, mandatory reviews, and specific design approaches.

Both categories can be fully defined only by:

- identifying all of the project stakeholders and their expectations, priorities and values;
- identifying the laws, rules, directives, and standards with which the project must comply; and
- working backward from the project mission and other end goals

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Project End Product

The Mission Need Statement is the starting point when capturing requirements related to the end product of the project in that it "translates an identified performance gap into functional requirements that cannot be met though other than material means." The Mission Need Statement generally addresses only one or two aspects of mission related requirements and does not provide enough information to allow a valid comparison of alternative conceptual approaches. Additional information is needed on the operational and life cycle aspects of the mission including:

quality	Survivability
processing	durability
operability	adaptability
reliability/dependability	decommissioning, deconability and disposition
maintainability and repairability	sustainability
availability	survivability; and
flexibility, agility, adaptability, upgradeability	testability

These topics are most readily determined by seeking input from stakeholders that will use or be impacted by the project and undertaking a function analysis of the mission. Internal functions most frequently impacted by the project include management and operating contractors' safety, environmental, and health; security; maintenance; utility or plant; and transportation organizations. External organizations likely to be impacted by the project are generally the same as internal organizations and include both state and local governments.

The identification of such operational and life cycle requirements is particularly important when there is not an accepted industry-wide norm to utilize in the absence of definitive information. Much of the "requirement creep" on projects can be traced to a failure to capture operational and life cycle requirements.

So that's a glimpse of DOE G413.3-1, and what it has to offer in perspective for the management design

and construction using a system's engineering approach. There is much more to learn or refresh, what ever the case may be, and this guide can be found in the PM Library [Managing Design and Construction Using Systems Engineering for Use with DOE O 413.\(current version\) — DOE Directives, Guidance, and Delegations](#)



It Is Not One World

20 Incredible Photos of the Construction of the Empire State Building



The Empire State Building, the 102-story skyscraper on Fifth Ave. between West 33rd and 34th Streets in Midtown Manhattan stands 1,454 feet tall. It was the world's tallest building for 39 years from its completion in 1931 until the World Trade Center's North Tower was completed in 1970. It has been named one of the Seven Wonders of the Modern World by the American Society of Civil Engineers.

Excavation of the site began on January 22, 1930, and construction of the building began on March 17. The project involved 3,400 workers, mostly European immigrants, as well as hundreds of Mohawk iron workers. Despite an astonishing lack of safety regulations, only five workers died during construction.

The construction of the Empire State Building was part of a competition in New York City for the "world's tallest building" with 40 Wall Street and the Chrysler Building. The Empire State Building surpassed both buildings in height upon its completion on April 11, 1931, 12 days ahead of schedule.



1929-1931 Empire State Building under Construction. *Image: Mashable*



Sept. 29, 1930 — Flirting with danger is just routine work for the steel workers arranging the steel frame for the Empire State Building, which became the world's tallest structure when completed. *Image: Pinterest*



Steelworker Carl Russell sits at 1,222 feet (400 meters) on top of a steel beam casually waving to the cameraman. *Image: Imgur*

All images retrieved from [Historycollection.com](https://www.historycollection.com/): Jacob Miller - July 23, 2017

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Empire State Building Construction

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Oct. 29, 1930 — A construction worker hangs from an industrial crane during the construction of the Empire State Building. Image: BETTMANN/CORBIS



Feb. 28, 1956 — Workmen place one of the new beacon lights in position on the 90th floor of an impressive electronic crown in the form of four far-reaching night beacons. Combined, the four Empire State Night lights will generate almost two billion candle power of light and will be the brightest continuous source of man-made light in the world. Engineers say the beacons can be seen from as far as 300 miles. Cost of the installation is \$250,000. Image: BETTMANN/CORBIS



July 30, 1945 — Workmen erect scaffolding on the 33rd Street Side of the Empire State Building as reconstruction work on the skyscraper begins. In spite of the damage the structure suffered when a B-25 crashed between the 78th and 79th stories, the world's tallest building was open today (July 30th), two days after the tragic accident. Image: BETTMANN/CORBIS



Sept. 19, 1930 "Workmen at the new Empire State building that is being erected on the site of the old Waldorf Astoria Hotel at 34th Street and 5th Avenue, in New York, by a corporation headed by the former Governor Al Smith, raised a flag on the 88th story of the great building, 1,048 feet above the street. The flag thus is at the highest point in the city higher than the Chrysler Building. Photo shows the workmen at the ceremonies. Image: BETTMANN/CORBIS



Sept. 29, 1930 — Erected on the site of the old Waldorf Astoria, this building will rise 1,284 feet into the air. A zepplin mooring mast will cap this engineering feat. Image: Mashable



Workers taking a break from construction. Image: RareDelights



Waiting for some scaffolding. Image: lparkatasztrofak



Working on an I-beam. Image: Pinterest



Photographer Lewis Hine was commissioned to document the process. He desired to capture the character rather than just architecture. Image: 6sajt



The very top of the Empire State Building, more specifically the steel, aluminum and glass-made spire. Image: RareDelights



Structural worker on a steel girder during the construction of the Empire State Building in 1930. Image: RareDelights

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Empire State Building Construction

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This spire was initially designed to be used as a mooring station for various aircraft, but the severe winds that are present at that particular altitude canceled the possibility of airship docking. *Image: RareDelights*



NYC. Manhattan. Construction of the Empire State building. 1929 – 1931. *Image: Pinterest*



Break during construction of the Empire State building. *Image: Pinterest*

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“The ‘P’ in PM is as much about ‘PEOPLE’ Management as it is about ‘PROJECT’ Management.”

~ Cornelius Fichtner, author of *The Short Guide to Becoming a PMP*, and host of the PM Podcast

Just for Fun: October's Notable Events and Famous Birthdays

1 — Yosemite National Park was established (1890), President Jimmy Carter was born (1924), the People's Republic of China was established (1949), Roger Maris broke Babe Ruth's single-season home run record with his 61st (1961), and 58 people were killed in a mass shooting in Las Vegas (2017).

2 — The Texas Revolution began (1835), Bob Gibson set the World Series single-game strikeout record with 17 (1968), **TV personality Kelly Ripa was born** (1970), and actor Rock Hudson died of AIDS (1985).



3 — Thanksgiving became an official holiday (1863), Iraq became an independent nation (1932), Britain successfully tested an atomic bomb (1952), and O.J. Simpson was acquitted of murder (1995).

4 — President Rutherford B. Hayes was born (1822), construction of Mount Rushmore began (1927), the Soviet Union launched *Sputnik*, the first artificial satellite, into orbit (1957), and Pope Paul VI became the first pope to visit the U.S. (1965).

5 — President Chester Arthur was born (1829), President Harry Truman delivered the first televised presidential speech (1947), the New York Yankees won a record fifth consecutive World Series title (1953), the first NC-17 film rating was given for *Henry & June* (1990), and Apple founder Steve Jobs died (2011).

6 — The first train robbery in the U.S. was staged (1866), and the Yom Kippur War between Israel and Egypt/Syria began (1973).

7 — The assembly line made its debut in a Ford factory (1913), East Germany was established (1949), rock star John Mellencamp (1951) and music judge Simon Cowell (1959) were born, and Operation Enduring Freedom began in Afghanistan (2001).

8 — **Automobile inventor Frank Duryea was born** (1869), the Great Chicago Fire began (1871), civil rights leader Jesse Jackson (1941) and actor Chevy Chase (1943) were born, Don Larsen pitched the only perfect game in World Series history (1956), actor Matt Damon was born (1970), and impeachment proceedings against President Bill Clinton began (1998).



9 — Hoover Dam began transmitting electricity (1936), and Beatle John Lennon was born (1940).

10 — The U.S. Naval Academy was established (1845), the first major operation of the Vietnam War began (1965), quarterback Brett Favre was born (1969), and stock car racer Dale Earnhardt Jr. was born (1974).

11 — Quarterback Steve Young was born (1961), the first manned Apollo mission launched (1968), and *Saturday Night Live* debuted (1975).

12 — Christopher Columbus reached the New World (1492), and singer John Denver died in a plane crash (1997).

13 — The Continental Navy was established (1775), the cornerstone of the White House was laid (1792), singer/songwriter Paul Simon (1941) and rocker Sammy Hagar (1949) were born, **Bill Mazeroski hit the first ever World Series-winning walkoff home run** (1960), and football Hall of Famer Jerry Rice was born (1962).



14 — General and President Dwight Eisenhower was born (1890), USAF Capt. Chuck Yeager broke the sound barrier (1947), the Cuban Missile Crisis began (1962), and rapper/singer Usher was born (1979).

15 — TV chef Emeril Lagasse was born (1959), and Wayne Gretzky broke the NHL career scoring record with 1,851 points (1989).

16 — Dictionary author Noah Webster was born (1758), China successfully tested its first nuclear bomb (1964), "Baby Jessica" was rescued from a well on live TV (1987), and 84 people died in a stampede at a World Cup match in Guatemala (1996).

17 — Motorcycle daredevil Evel Knievel (1938) and rapper Eminem (1972) were born, OPEC enacted an oil embargo on the U.S. and other nations (1973), and a 7.1 magnitude earthquake hit the Bay Area, postponing Game 3 of the World Series for 10 days (1989).

18 — The Mason-Dixon Line was established (1767), the U.S. took possession of Alaska (1867) and Puerto Rico (1898), singer Chuck Berry (1926), and NFL coach Mike Ditka and JFK assassin Lee Harvey Oswald (1939) were born.

19 — The American Revolutionary War ended with the British surrender at Yorktown, Va. (1781), and Maurice Richard became the first NHL player to score 500 goals (1957).

20 — The Louisiana Purchase was ratified (1803), baseball Hall of Famer Mickey Mantle (1931), rocker Tom Petty (1953) and rapper Snoop Dogg (1972) were born, and three members of Lynyrd Skynyrd died in a plane crash (1977).

21 — Jazz trumpeter Dizzy Gillespie (1917) and actress Carrie Fisher (1956) were born, and about 100,000 antiwar protesters marched on the Pentagon (1967).

22 — Actor Christopher Lloyd was born (1938), the U.S. suffered its first casualties in Vietnam (1957), President John F. Kennedy ordered a blockade of Cuba (1962), and Lance Armstrong was stripped of his 7 Tour de France titles (2012).

23 — TV personality Johnny Carson (1925) and musical parodist Weird Al Yankovic (1959) were born, and **a car bomb exploded at the U.S. Marines barracks in Beirut, Lebanon, killing 241** (1983).



24 — The first transcontinental telegraph line was completed (1861), the United Nations was formally established (1945), Toronto won Canada its first World Series title (1992), and the supersonic Concorde jet made its last flight (2003).

25 — Artist Pablo Picasso was born (1881), and the U.S. invaded Grenada (1983).

26 — The Erie Canal opened (1825), the Shootout at the OK Corral occurred (1881), TV gameshow host Pat Sajak and politician Hillary Clinton (1947), and actor Dylan McDermott (1962) were born, and President George W. Bush signed the Patriot Act (2001).

27 — President Theodore Roosevelt was born (1858), New York's subway system began operation (1904), the Cuban Missile Crisis ended (1962), and the Boston Red Sox won their first World Series title in 86 years (2004).

28 — The Statue of Liberty was dedicated (1886), Congress overruled President Wilson's veto and enacted Prohibition (1919), rich guy Bill Gates (1955), PM guru and *Practitioner* editor Craig Hewitt (1959), and actress Julia Roberts (1967) were born, and the Digital Millennium Copyright Act was signed (1998).

29 — The stock market crashed, touching off the Great Depression (1929), actor Richard Dreyfuss was born (1947), the Suez Crisis began when Israel invaded Egypt (1956), and guitarist Duane Allman died in a motorcycle crash (1971).

30 — President John Adams was born (1735), **"The War of the Worlds" was broadcast, causing a nationwide panic** (1938), actor Henry Winkler was born (1945), and Muhammad Ali beat George Foreman for the heavyweight title in the "Rumble in the Jungle" (1974).



31 — Nevada became a state (1864), Magician/escape artist Harry Houdini died (1926), Earl Lloyd broke the color line in the NBA (1950), rapper Vanilla Ice was born (1967), and Indian prime minister Indira Gandhi was assassinated (1984).

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