

10 Things Every Engineer Should Know About Project Management

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What Should We Know ?



1. Project Management Is Everywhere
2. Project Management Began 5000 Years Ago
3. Project Management Has Changed The World
4. Effective Project Management Is Really The Integration Of Several Systems
5. Project Management is part of you (whether you like it or not 😊..)



And ...

6. Project Management Has Changed The Way Companies Are Organized
7. Project Management Tools Are Simple And Can Easily Be Applied By You
8. Project Management And Engineering Is A Powerful Marriage
9. You Will Need To Study Project Management To Succeed In Your Career
10. PMI Is The Fastest Growing Professional Society In The U.S.



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I. Project Management Is Everywhere

⌘ **We Know:** PM is widely adopted in complicated projects

⌘ **BUT:**

- PM actually applies to each of our lives and work
- PM is also utilized for something we do not establish a goal ahead of time
- Examples ?

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Ex1: WEDDING

⌘ A wedding is a project



- ☑ Objective: get married!
- ☑ Specific end date
- ☑ Different stages
- ☑ Multiple stakeholders and members
- ☑ Limited budget

How Project Management is Utilized

⌘ Planning:

- ☑ Time-based schedule: choose a venue selection by a certain date; prepare for reception, dinner, etc.
- ☑ Resources: your family and network of friends

⌘ Organizing:

- ☑ Project Manager = bride and bridegroom
- ☑ Stakeholders = parents, friends
- ☑ Team members = caterer, musician

⌘ Execution:

- ☑ Project Managers work with the team

⌘ Monitor & Control:

- ☑ Budget, time and quality
- ☑ Prepare for changes: a delay from a clothes provider



Ex 2: Accreditation: ABET Preparation

⌘ Preparation of Accreditation Board for Engineering and Technology (ABET) is a huge task for your professors!!

- ☒ Numerous materials and documents
- ☒ Lasts for several years
- ☒ Without a systematic process, ABET preparation is easily transformed into a last minute crash project



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Where is Project Management?

- ⌘ **Planning:**
 - ☒ Joint decision from stakeholders: faculty, students, employers
 - ☒ Share information by communication tools: emails, meetings, share point
- ⌘ **Organizing:**
 - ☒ Identify ABET requirements
 - ☒ Benchmark successful programs
 - ☒ Satisfy ABET expectations: matriculate students, hire faculty, establish and assess program objectives and student outcomes
- ⌘ **Execution:**
 - ☒ Example: deliver classroom instruction, mentor students
- ⌘ **Monitor & Control:**
 - ☒ Monitor the quality of educational performance: exam grades
 - ☒ Collect instructors' evaluation of courses

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Ex3: Recovery from Disasters



⌘ Hurricane George on September 17, 1998

- ☒ A refinery on Mississippi's coast was entirely forced to stop
- ☒ Four main buildings were flooded
- ☒ All ground level equipment was destroyed

Project Management Steps Forward

- ⌘ **Planning:**
 - ☒ Define damage level
 - ☒ Identify and partner with contractors and resources
- ⌘ **Organizing:**
 - ☒ Effectively communicate with refinery personnel, partners and contractors to allocate the right team at right place at the appropriate time.
- ⌘ **Execution:**
 - ☒ Remove damaged equipment by the engineering team
 - ☒ Provide alternative machines by partners
 - ☒ Determine logical sequence of recovery and crucial activities with high priority: physical plant systems
- ⌘ **Monitor & Control:**
 - ☒ Trade-off between reconditioning cost and replacement cost

II. Project Management Began 5000 Years Ago

- ⌘ PM was formalized in the 1950s, but its roots go as far back as ancient Egypt
- ⌘ Ancient Egyptians were the first recorded project managers
- ⌘ Pyramids was one of the largest civil projects on record



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The Great Pyramid of Giza

- ⌘ The largest pyramid
- ⌘ Constructed during 2550 B.C.
- ⌘ 481 feet Height
- ⌘ The tallest structure on Earth for more than 43 countries
- ⌘ Workers needed food and housing
- ⌘ Builders had religious belief
- ⌘ Treated well and accessed to medical care
- ⌘ Separated workforce into competing teams
- ⌘ Each group took charge of specific tasks
- ⌘ Managed and distributed food at right time and quantity
- ⌘ Left tolerance for changes from Pharaoh



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III. Project Management Has Changed The World

- ⌘ Many projects have greatly impacted the society, economy and culture around the world
- The Project Management Institute: "one-fifth of the world's GDP, or more than 12 trillion dollars, is spent on projects"
- Organizations need projects to increase profitability, reduce costs, improve customer satisfaction, minimize risks and keep competitive advantage
- ⌘ PM allows companies to break the traditional cultural and geographic borders, facilitates the global cooperation
- ⌘ Project Management Talent Gap Report: 15.7 million new PM-related jobs will be created between 2010 and 2020 all over the world

Ex1: The Panama Canal (1870-1914)

⌘ Background

- ☒ Started by a French Company in 1870
- ☒ Completed by the United States in 1914
- ☒ The canal was regarded as the most costly venture for Americans that had ever accomplished outside the borders



A Costly Venture for the U.S.

- ⌘ Overcome the arduous engineering, technic and logistic challenges
 - Push the development of science and technology
 - Gain valuable experience about working on the large complex project by single efforts
- ⌘ The strategic channel of wars
 - The vital connection between the Atlantic Ocean and the Pacific Ocean
- ⌘ International trade was greatly benefited
 - ☒ Ships travelling from east to west coast of the U.S. can save as many as 6 weeks
- ⌘ The causal issue for malaria was identified by Walter Ross

Ex2: Oil Exploitation from Saudi Arabia (1930s)



⌘ Background

- Saudi Arabia did not have the resources but wanted to establish a new economic front by the oil exploitation at the Gulf region
- May 29, 1933: Saudi Arabia and Standard Oil Company of California signed an oil concession agreement
- 1934: the first oil field was located
- 1935: the first test well was drilled
- March 4, 1938: the first commercial quantities of oil at Dammam Well No. 7 was discovered

The World's Energy Lifeline: Oil

- ⌘ Directly changed Saudi Arabia from a desert kingdom to a nation under the energy spotlight
 - Invaluable oil resource
 - Large fortunes were made (and lost)
- ⌘ Established a global economic and trade network
 - Export oil resource to many countries
- ⌘ The focus of the world
 - People all over the world are paying a close attention on the oil price
 - Our earth is suffering an increased resource and energy crisis

Ex3: The Itaipu Dam (1960s)

Background

- ◆ July 22, 1966: Brazil and Paraguay signed an act to establish a mutual interest in exploiting the hydraulic potential of the Parana River
- ◆ 1970: American company IECO and Italian firm ELC Electroconsult won the international competition for undertaking the project
- ◆ January, 1975: project started
- ◆ May 5, 1984: the first power-generating unit was completed



The World's Largest Functioning Hydroelectric Plant

The world's largest operating hydroelectric plant

- ✓ Generate 94.7 TWh in 2008 and 91.6 TWh in 2009
- ✓ Installed capacity 14,000 MW only second to the Three Gorges Dam

Big influence on Brazil and Paraguay

- 19.3% of the electricity are consumed by Brazil and 87.3% by Paraguay
- In 2008, each of the two countries received 218.9 million dollars royalties
- Important impetus to the development of Brazil
- One of the top revenue sources for Paraguay

Ex4: The Three Gorges Dam (1994-2012)

⌘ Background

- 1918: Mr. Sun, Zhongshan, an engineer and PM first provided the initial concept of utilizing the water resource of the Yangtze River
- December 14, 1994: the project officially launched
- 2012: the dam was finally able to fully operate with the world's largest capacity 22,500 MW and annual generation of the power 80 TWh



The World's Largest Hydro-power Engineering Project

Economic Benefit

- ✓ Generate a power of 7,200 MW to the east part, 12,000 MW to the central area and 3,000 MW to the south lines in China
- ✓ Reduce the peak discharge 30,000 m³/s
- ✓ Remarkable navigation benefits

Environmental Destruction

- ✗ Erode 80% of the land and deposit 40 million tons of sediments into the Yangtze annually
- ✗ Over 3,500 species are endangered
- ✗ The percentage of forecasted area has decreased from 20% in 1950 to less than 10% in 2002

Captures attention from all over the world to study and discuss how to deal with the large complex projects:

Economic Benefit vs. Sustainable Development **PITT** | SWANSON
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Ex5: The National Institute of Nanotechnology (2001-2006)

⌘ Background



- ☒ Established in 2001
- ☒ A joint project conducted by National Research Council of Canada, University of Alberta and Province of Alberta
- ☒ By 2006, the collaborative project was completed with a total 21,086 square meters and an investment of 52 million dollars

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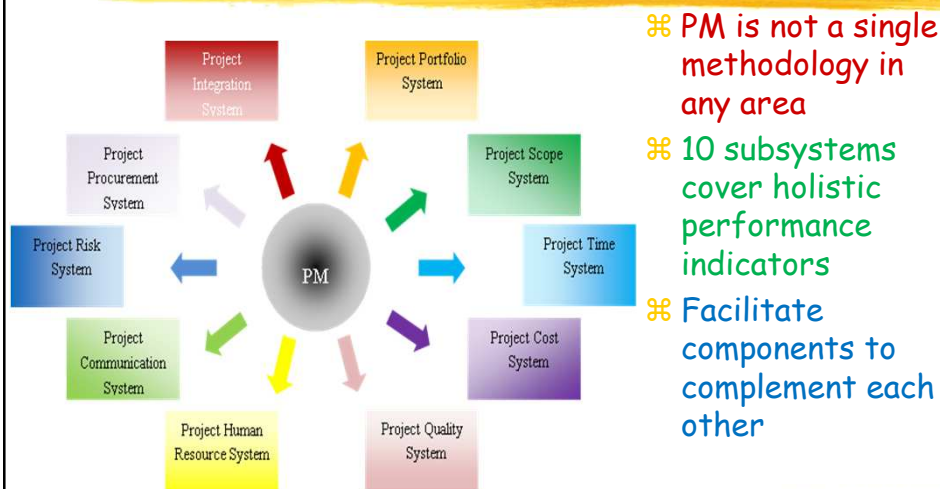
New Frontier of Project Management Will Continue to Change the World

- ✓ Attract the world’s best minds in the nanotechnology area
- ✓ The potential application in the wide range: computing, communications, medicine, energy, materials, electronics, etc.
- ✓ In 2008, more than 4 billion dollars was invested into the nanotechnology
- ✓ “It will change our world in the next 100 years more than all other changes in the last half of a millennium”

* Project Management Circa, 2025



IV. Effective Project Management Is Really The Integration Of Several Systems



- ⌘ PM is not a single methodology in any area
- ⌘ 10 subsystems cover holistic performance indicators
- ⌘ Facilitate components to complement each other

* PMBOK, 2008



Strategic Systems



⌘ Project integration system

- ✓ Coordinate different components into an organic combination
- ✓ Balance competing objectives and optimize overall performance: quality versus cost
- ✓ Capture changes

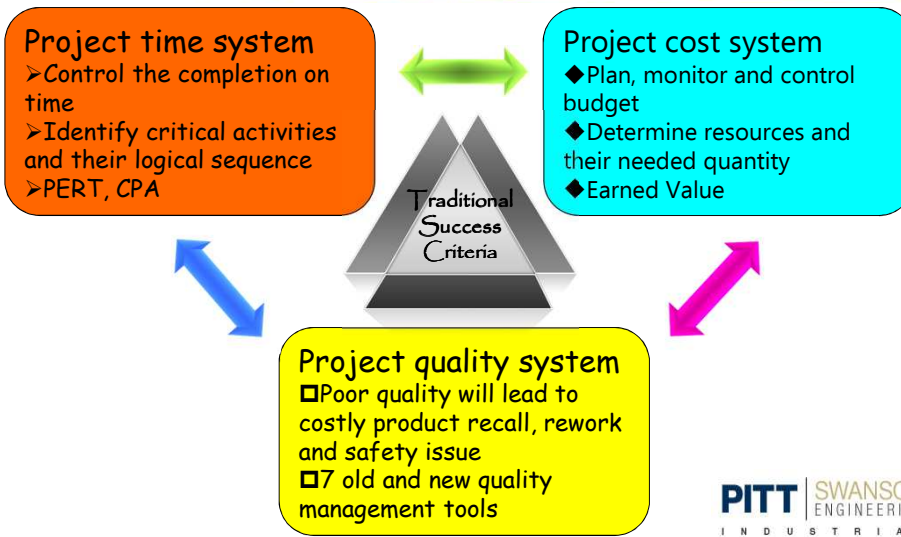
⌘ Project portfolio system

- ✓ Decide which projects should be launched
- ✓ Make evaluation based on profitability, risk, strategic fit, etc.

⌘ Project scope system

- ✓ Define what is or is not necessary for a project success
- ✓ Product scope and project scope

Classic Iron Triangle



Personnel and Information

Project human resource system

- ❑ Identify stakeholders
- ❑ Assign responsibility to team members
- ❑ Coordinate personnel relationships



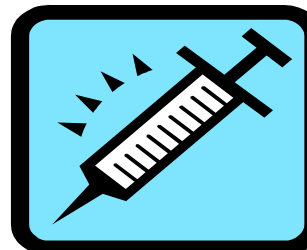
Project communication system

- ◆ Generate, collect, transmit and analyze information
- ◆ Project Management Information System

Risk and Procurement

Project risk system

- Increase desirable results from positive events
- Decrease negative consequences from emergencies
- Checklist, flowchart, simulation



Project procurement system

- ✓ Select suppliers
- ✓ Trade-off between cost, quality and risk

V. Project Management is part of you (whether you like it or not!)

- ⌘ PM is surrounded by physical, cultural, organizational and social environment
- ⌘ These environments dynamically generate influences on a project
- ⌘ Project success is measured by those influential elements
Ex: customer satisfaction



* Wideman, 1990

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Cultural Environment

- **Focus on stakeholders**
Organization, investors, team members, partners, contractors, clients, competitors
- Project managers have at least three roles
 - a) Lead the team
 - b) Report to superior
 - c) Work with partner and contractor
- Examples – globalization
 - a) Team members work at different remote locations
 - b) Global contract: harder to track and ensure quality or timeliness



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Social Environment



■ Projects generate social effects

Safety, pollution, local tribe issues

■ Try to obtain the support from the majority

■ Example - water conservancy or transportation project

① Consume a mass of machines and materials

② Take several years to finish

③ Exorbitant

④ Occupy lots of space

➤ Set up good public relations through media or local dignitaries



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Economic Environment

⌘ Investment is a premise for project success

⌘ Economic system greatly fluctuates from country to country

⌘ Example - European debt crisis



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Law & Regulation Environment

- A double-edged sword
 - Offer the right and privilege after a project is accredited
 - Place limitations on actions and parties
- **A common mistake!!!**



Carefully study the country-specific principles, but neglect the local-related rules

Ex: U.S. and China

- Central government publishes country-level laws and regulations
- City- and county-level rules sometimes have higher power



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Technical Environment

- ⌘ Science and technology are changing rapidly
- ⌘ Advanced technics vs. high investment and system reconfiguration

Ex: Forecasting demand in the airline industry

- From two-class, single-resource model to customer choice and simulation model
- Better forecasting vs. cost of updating systems, hiring or training analysis experts



VERSUS



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Natural Environment



- ⌘ Natural disasters may cause destructive attack on an initial, in progress or completed project
 - Typhoon, storm drought, earthquake
- ⌘ Example - Sharp located new buildings back to Japan
 - Pros: capital investment, closer to marketplace, policy support
 - Cons: potential fatal threat from earthquake

* Wakabayashi, 2009, The Wall Street Journal

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VI. Project Management Has Changed The Way Companies Are Organized

Two traditional organizational structures:

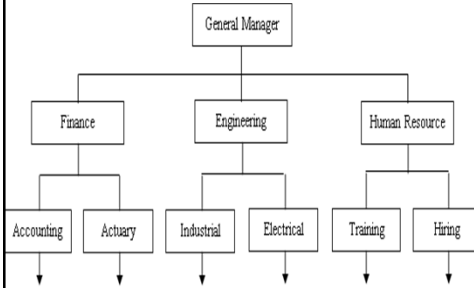
- **Functional structure** focuses on developing high-tech products
- It clearly separates departments based on expertise
- **Product or project organization** concentrates on end product or project goals
- It collects experts in different fields to work together on a given task

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Functional versus Project Organization

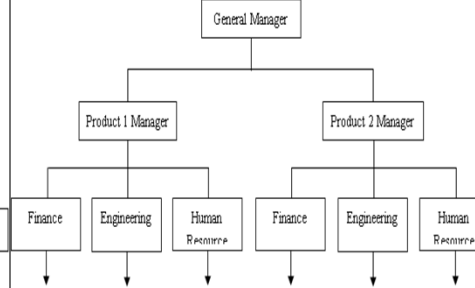
Functional Structure

- Various expertise are highly developed
- Impossible to simultaneously complete the tasks required multiple inputs timely and reliably



Project Structure

- Dedicated concentration on current work
- Skill diversification is reduced and technological obsolescence may happen

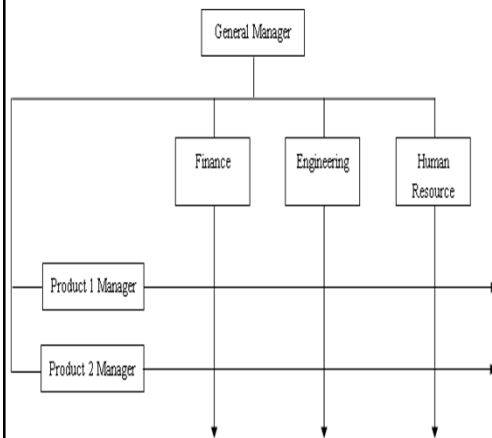


* Matrix Organization & Project Management, P.46

* Project Management: A Systems Approach To Planning, Scheduling, And Controlling, P. 104



Matrix Organization



- ⌘ Consistent with the implementation of PM and support PM from the fundamental personnel structure
- ⌘ Balance the authority and development between permanent functional structure and temporary project organization
- ⌘ Share resources: techniques, staff, information, managerial skills
- ⌘ But generate overlap responsibility and authority

* Project Management: A Systems Approach To Planning, Scheduling, And Controlling, P. 106



Matrix Organization

PRO VS. CON

Advantage

- Better information processing
- Rapid response for slow-moving projects
- Reduced cost: experts' sharing
- Opportunity for individuals to study



Disadvantage

- ☐ Ambiguity and conflicts
- ☐ Slower reaction time for fast-moving projects
- ☐ Increased cost: hire management staff, organize cross-functional meetings, designing new policies



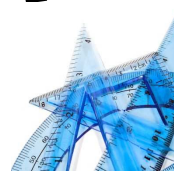
Matrix Organization Works Well!



- ⌘ Successfully adopted by a range of industries
 - ☒ Engineering, R&D, financial, health care
- ⌘ Shortcomings can be minimized by managerial skills
- ⌘ Globalization generates more and more dynamic and complex projects
 - ☒ Matrix organization is a basic and effective structure to allocate resources and assign manpower

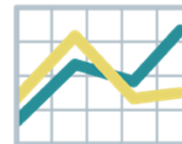
VII. Project Management Tools Are Simple And Can Easily Be Applied By You

- ⌘ Many useful tools are derived from the development of PM to organize, plan, execute, monitor and control
- ⌘ Some have become the standard criteria that are widely adopted by organizations
- ⌘ Examples ? ?





Ex1: Project Network

- ⌘ It was invented with the development of Program Evaluation and Review Techniques and Critical Path Method for US defence projects in 1950s
- ⌘ Graphically develop the project plan
- ⌘ Measure project performance
- ⌘ Determine correction actions
- ⌘ Utilized in the areas of construction, high-tech, movie production, advertising campaign, and so on



How to Develop a Project Network

Plan

- Identify activities and their time, cost and other attributes
- Connect activities by activity-on-arrow or activity-on-node

Schedule


- Calculate the slack of each activity and determine the critical path
- Apply PERT to estimate the probability of completing a project on time


Monitor & Control

- Time/cost trade-off between decreasing duration versus increasing cost
- Timely track the progress and establish corrective actions as needed

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The future of Project Networks?





⌘ New element - simulation

- ☒ Provide different probability distributions for modeling the uncertain durations of activities
- ☒ Offer what-if analysis function to change the parameters in the model so that dynamic conditions in practice can be tracked

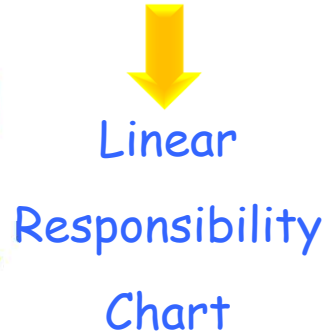
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Ex2: Linear Responsibility Chart

When companies use matrix organization, how to deal with the increased interacted responsibility and authority?

As firms growing larger and finally becoming global enterprise, complex personnel interrelationship and job definition require new procedures to regulate the cross-functional and cross-organizational cooperation

The potential conflict between functional and project manager poses challenges for PM

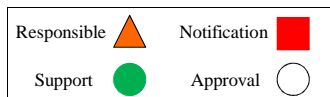


Let Us Create a Simple LCR

A Car-manufacturing Project

WBS and Expert Judgment	Responsibility			
	Project Manager	Chief Engineer	Chief Operator	Chief Marketer
Form Team	▲	●	●	●
Define Goals	▲	○	○	○
Assemble Components	■	▲	●	
Prototype Test	○	▲	●	
Sign Contract	○	●	▲	
Market	■		●	▲

- ⌘ First column fills in the description of each activity
- ⌘ First row identifies the stakeholders
- ⌘ The intersection cell shows different symbols represented below the chart



What Linear Responsibility Chart Can Do

- ⌘ Define who is responsible for which job and what is the job
- ⌘ LRC makes a clear difference when more than two executives work on a same job so that overlapping authorities can be minimized
- ⌘ The relationship revealed in the chart shows how a position is connected with another one, which is meaningful to drive the communication and cooperation
- ⌘ Although there is no information at a molecular level about how a person should do a job, LRC has turned to be one of the most effective tools in team management

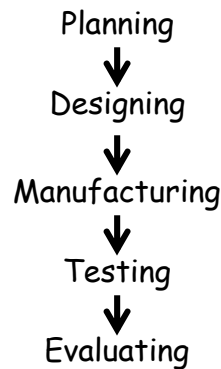
VIII. Project Management And Engineering Is A Powerful Marriage

- ⌘ It is difficult to achieve success without the support of hard technology for large complex projects
- ✓ An engineering science provides the indispensable expertise
Ex: civil engineering for construction projects
- ✓ The coordination and integration between project elements ask for engineering to reduce time and budget while improve quality and efficiency
- ⌘ Example ??



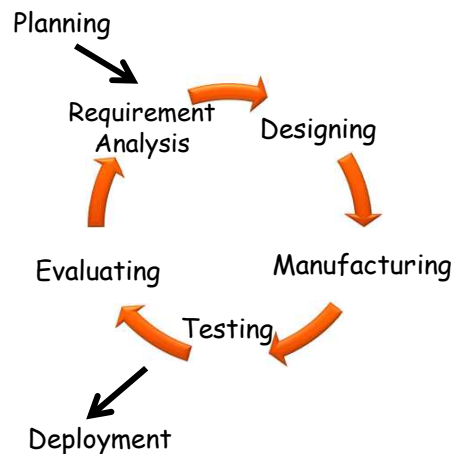
Ex1: Concurrent Engineering

- ⌘ Why: cost reduction, quality improvement, shortening of product life cycle
- ⌘ Traditional way: sequential engineering



What is Concurrent Engineering ?

- ⌘ A systemic approach to accomplish the work simultaneously
- ⌘ Require designers, manufacturing engineers, deployment managers, marketers, etc., to all participate into the early project stage, especially the design phase to share information and ideas
- ⌘ Generate better ideas and lay a good foundation for following processes by reducing engineering changes



Concurrent Engineering Makes Things Different

- ⌘ Cultivate the culture of multifunctional team work
 - Innovation and creativity are facilitated
- ⌘ Decrease the cost and save the resource
 - Reduce the engineering changes
- ⌘ Increase the quality and profitability
 - Minimize the risk of poor decisions when multifunctional team members work together
- ⌘ Adopted in a variety of industries
 - Military defence, aircraft, health care



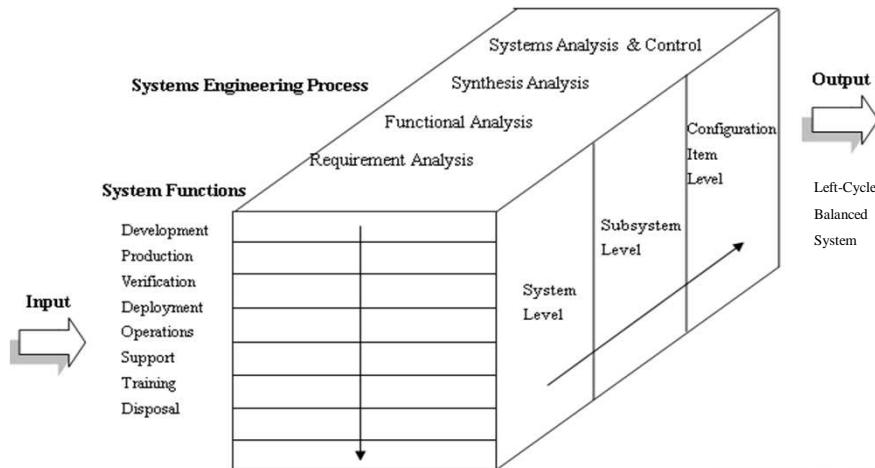
Ex2: Systems Engineering

- ⌘ The large, complex projects cover multiple disciplines
- ⌘ These engineering intensive projects are constituted by designing, development, production, prototype testing and operational deployment
- ⌘ Need a systematic and logic process to comprehensively address complexity and satisfy customer needs

What is Systems Engineering ?

- Systems engineering transforms each operational requirement into a holistic system by iterative definition, synthesis and control
- It integrates system functions and technical needs into a life-cycle balanced way
- The total system is optimized and all project objectives are realized

The Framework



* Military Project Management Handbook, P. 2.3

The Powerful Marriage between Project Management and Systems Engineering

- ⌘ Reduce the time and improve the quality
 - ☒ Information & technology-oriented organizations, electronic & communication companies
- ⌘ International Council on Systems Engineering (2001)
 - ☒ Optimal systems engineering effort is 15-20% of the total project effort
 - ☒ Systems engineering budget is only 3-8%



WEIGH IT !!!

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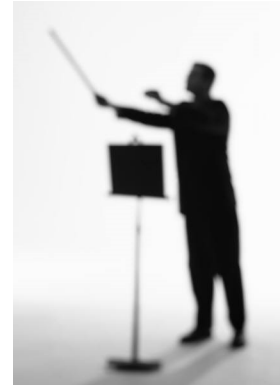
IX. You Will Need To Study Project Management To Succeed In Your Career

- ⌘ PM was focused on developing quantitative techniques and tools..... **BUT...**
 - ✓ Increased research and practical attention has been drawn into intangible elements, or human dimensions
 - ✓ El-Sabaa (2011) concluded that human skills of project managers generate the top influence on project successes versus least effect from technical skills
- ⌘ Many professionals in different areas need to study versatile PM skills in order to keep competitiveness and pursue a broader opportunity
 - ✓ Ex: engineers look for jumping out of the limited career in a specific functional discipline by learning human behaviors and interpersonal relations from PM

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Learn About Leadership from Project Managers

- ⌘ Leadership competencies can be successfully applied at all levels within any industries
- ⌘ The leadership aspects shown by a project manager is meaningful for all managers
- ⌘ Examples:
 - ☒ Manage stakeholders
 - ☒ Involve people
 - ☒ Motivate the team



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The Recognition and Management of Multiple Stakeholders

Identify stakeholders



Understand what they want and try to avoid



Develop communication and leading strategies



Predict their behavior in the future

- Win people's support by working with and through them
- Rely on stakeholders and show a strong set of interpersonal skills to win loyalty, respect and trust

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Empowerment and Involvement

Project managers need to make everyone feel that they are important for the project and their efforts will generate a direct effect on the project success

- Build good team morale
- Increase members' commitment to the organization
- Improve the team effectiveness



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Motivation



- ⌘ Especially meaningful when any bad news and fear of failure negatively influence the team morale and faith
 - ☑ Failure is just a one-step ahead of the success and it enables us to learn and eventually find the avenue to success
- ⌘ Cultivate an atmosphere of high motivation
 - ☑ Daily opening communications
 - ☑ Care about teammates in a personal sense

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If You Fail to Plan, You Plan to Fail

⌘ One of the premises for the successful project completion is planning:

- ☒ Define overall structure of different project stages
- ☒ Assign personnel to appropriate positions
- ☒ Establish performance requirements
- ☒ Leave tolerances for unexpected changes

⌘ Planning skills are also beneficial for other undertakings:

- ☒ Initiate a music concert by a theatre principal
- ☒ Organize a spring outing through a teacher
- ☒ Conduct an interview for a hiring supervisor



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X. The Project Management Institute Is The Fastest Growing Professional Society In The U.S.



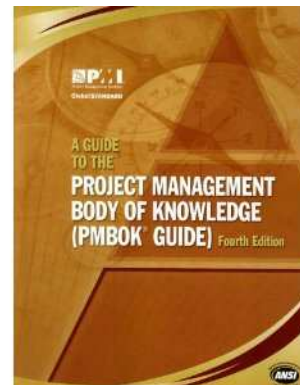
A Large Number of Advocates



- In 1990 PMI had approximately 8,000 members
- Two decades later it has reached over half a million members in more than 180 countries
- The professional resources and research empower over 700,000 members, credential holders and volunteers internationally to improve their organization's success and further mature the profession

Project Management Body of Knowledge

- PMI introduced the PMBOK guide in 1987
 - A reference manual that provides the fundamentals of PM in a clear and concise manner
 - Update every four years since 1996
 - Currently more than 1 million copies in circulation
- The Institute of Electronics and Electrical Engineers (IEEE) has adopted PMBOK as their PM standard
- PMBOK is essential for those pursuing Project Management Professional (PMP) certification



Certification Exam



- ⌘ Began in 1984
- ⌘ PMI is the first organization to have its certification program attain International Organization for Standardization (ISO) 9001 recognition
- ⌘ Today more than 260,000 individuals around the world hold the PMP certification

Questions... Comments...???

