Week 4

Pre-Project Planning (2)

457.657 Civil and Environmental Project Management

Department of Civil and Environmental Engineering

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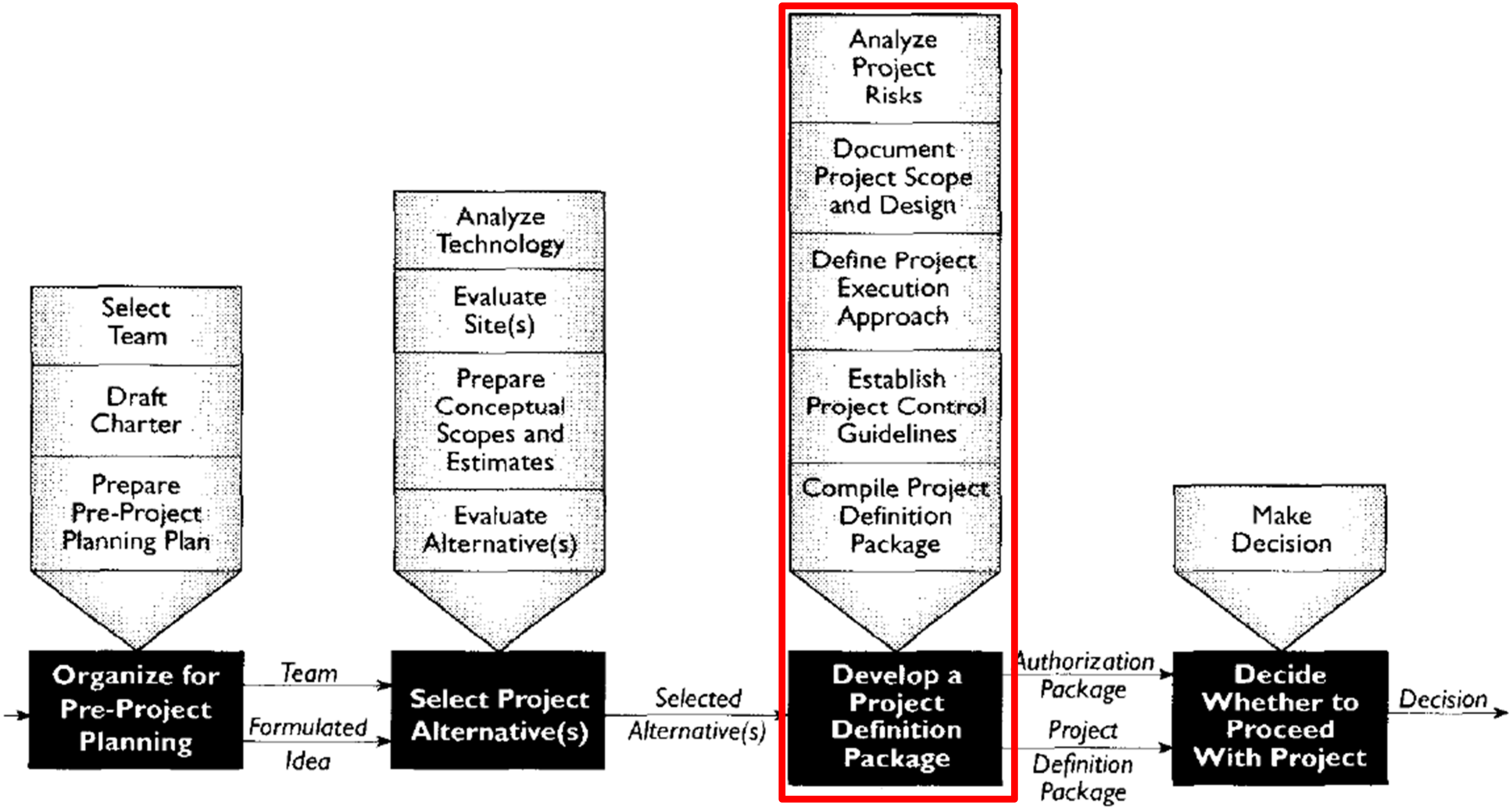
(3) Develop a Project Definition Package



(3) Develop a Project Definition Package

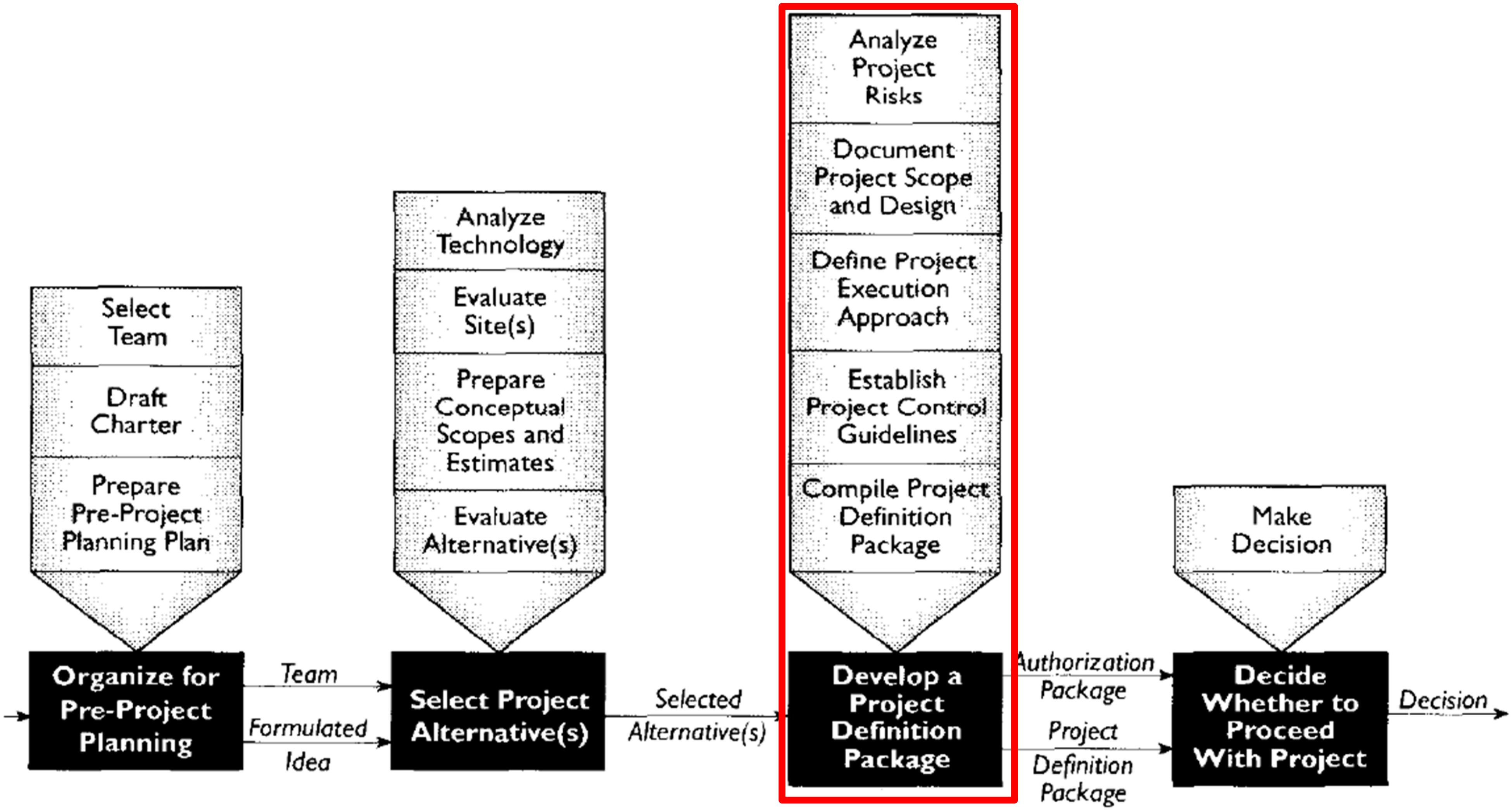
- **Analyze Project Risks**
  - Uncertainties produce severe losses
  - Identify, measure and manage project risks on cost, schedule, and technical performance
  - Mostly subjective and qualitative
    - Experience of key project personnel
    - Input from stakeholders is critical.
  - Financial, business, technology, regulatory, operational, environmental, permitting + construction-related risks

(3) Develop a Project Definition Package

- **Two critical risk considerations:**
  - Which risks may produce severe losses?
  - Which risks may occur frequently?

- **Key things**
  - Capture risk issues in a risk matrix or "risk register"
  - Begin as early as possible
  - Develop mitigation strategies
    - Accept, shift through contract, design solutions, apply contingency $ or plans, or insure
  - Track over time

(3) Develop a Project Definition Package



(3) Develop a Project Definition Package

- **Document Project Scope and Design**
  - All key elements of the scope should be identified and addressed in as much detail
  - Fundamentals of scope development affecting design planning and decision making
    - Project definition
      - Statement of key technical and physical attributes
    - General building requirements
      - Building features required to support operations
    - Integration requirements
      - Procedures necessary for renovating an existing facility to accommodate the new operations
    - Process design basis
      - Design characteristics necessary to support the new process

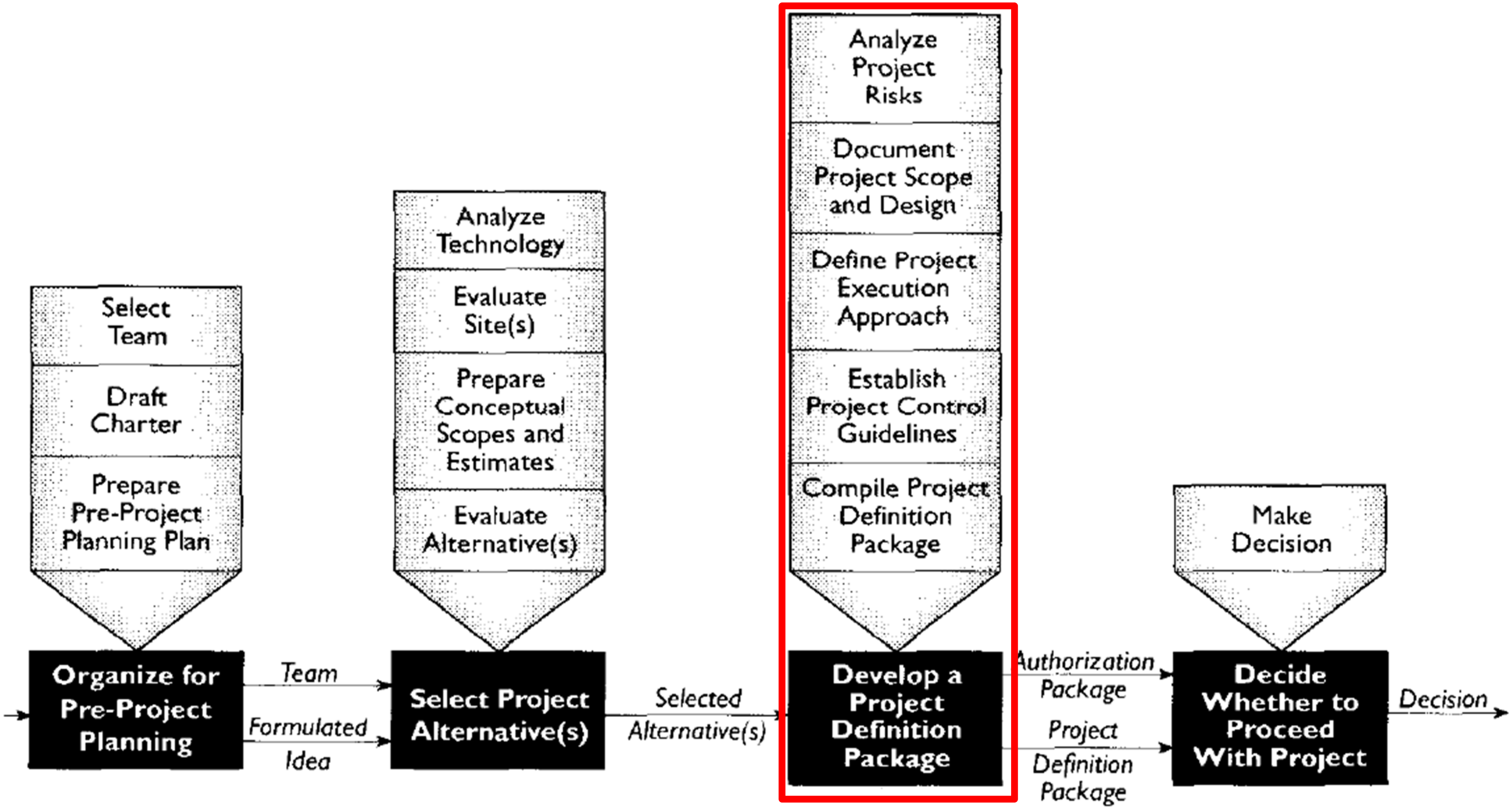
(3) Develop a Project Definition Package

- **Document Project Scope and Design**
  - Fundamentals of scope development (cont'd)
    - Utility design basis
      - Design characteristics of the utilities necessary to support the new process
    - Control system design basis
      - Design characteristics of the controls necessary to support the new process
    - Equipment list and data sheets
    - Electrical, piping and instrumentation schematics
    - General site information

(3) Develop a Project Definition Package

- **Document Project Scope and Design**
  - Critical considerations for scope control
    - Minimize non-income producing investments
      - e.g., Unnecessary upgrades
    - Complex scope items
      - e.g., Complex control systems
    - Equipment cost multipliers
      - e.g., Non-standard equipment items
    - Expensive materials of construction
      - e.g., Exotic finishes
    - Management of changes

(3) Develop a Project Definition Package



(3) Develop a Project Definition Package

- **Define Project Execution Approach**
  - All tasks are identified and carried out in a timely manner even in the early stages of project development
  - Define who, how, and when
  - Available resources affects approach
  - Project schedule
    - What will be included?
  - Design implementation plan
    - What questions must be answered when deciding design approach?

(3) Develop a Project Definition Package

- **Define Project Execution Approach**
  - Contracting and procurement plan
    - Potential options?
  - Permitting and compliance plan
    - Who assumes the risk?
  - Materials management / procurement plan
    - Who purchases major equipment?
    - Who assumes the risk?
  - Safety process
    - May cut across all stages of the execution
  - Cost/Schedule controls
    - Covered in next section
  - Staffing plan
    - Who is responsible at each stage of execution?
    - Who assumes the risk at each stage?

Example – Define Execution Approach

- ## Project Schedule

	Tasks	Duration (Month)	Start date	Finish date
1	Pre-project planning	3	01/01/2007	03/31/2007
2	Authorization to proceed	1	04/01/2007	04/30/2007
3	Engineering	16	05/01/2007	08/31/2008
4	Permit application and approval	19	06/01/2007	12/31/2009
5	Procurement and construction strategy	1	05/01/2007	05/31/2007
6	Long-lead items procurement	14	06/01/2007	07/31/2008
7	Bidding	3	03/31/2007	05/31/2007
8	Award construction contracts	3	06/01/2007	08/31/2007
9	Construction	19	08/01/2007	02/28/2009
10	Commissioning and start up	1	03/01/2009	04/30/2009
11	Product testing and stabilization	2	05/01/2009	06/30/2009
	(Product ready for commercial delivery)			

- ## Contracting

**EPC: Engineering, Procurement, and Construction Contractor*

	Facilities	Contracting strategy	Alternative strategy
1	Process unit	Design/Build	CM with EPC (CM at Risk)
2	Power plant	Design/Build	CM with EPC (CM at Risk)
3	Admin. building	Design/Bid/Build	Design/Build

Example – Define Execution Approach

- **Design**

	Facilities	Designer
1	Process unit	A/E with PMC
2	Power plant	A/E with PMC
3	Admin. building	A/E
Project Management Consultant (PMC)		
Additional design studies - Geotechnical investigation - Special foundation requirements for admin. building - Transportation/Public distribution network studies		

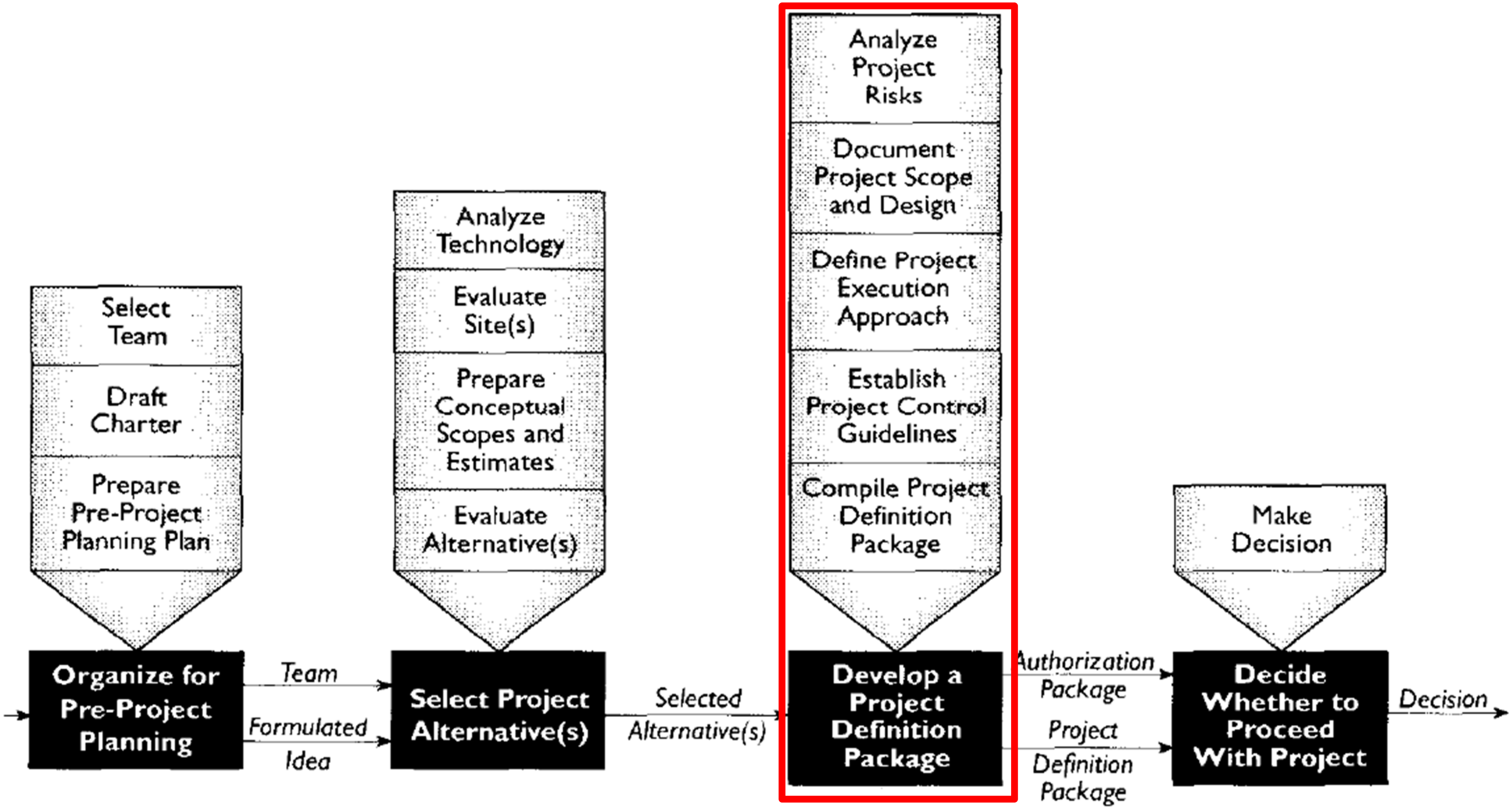
- **Permitting**

	Permit	Start	End	Responsibility
1	Construction permit	09/01/2007	06/15/2007	Owner*
2	Process permit	04/15/2007	05/15/2007	Owner*
3	Construction safety permit	08/15/2007	09/15/2007	Contractor
4	Operation safety permit	05/01/2008	12/31/2008	Owner*
* Assisted by PMC				

Example – Define Execution Approach

- **Materials**
  - Long-lead items
    - Extrusion processing equipment, Gas compressor, Gas turbine, High pressure pump
  - Who will purchase
    - All items will be purchased by the owner.
  - How do the long-lead items impact the schedule?
    - They are on the critical path schedule. (Any delay on this leads to delay of the entire project.)
    - Associated facilities' construction schedule has to be matched to ensure minimum time expenditure in housing of the equipment after receipt.

(3) Develop a Project Definition Package



(3) Develop a Project Definition Package

- **Establish Project Control Guidelines**
  - Compare actual performance to planned performance and take action to correct poor performance when necessary
  - Control time and money
  - Status reporting and change management
  - These will be discussed in detail through the semester

Example – Establish Control Guidelines

- **Preliminary Budget**

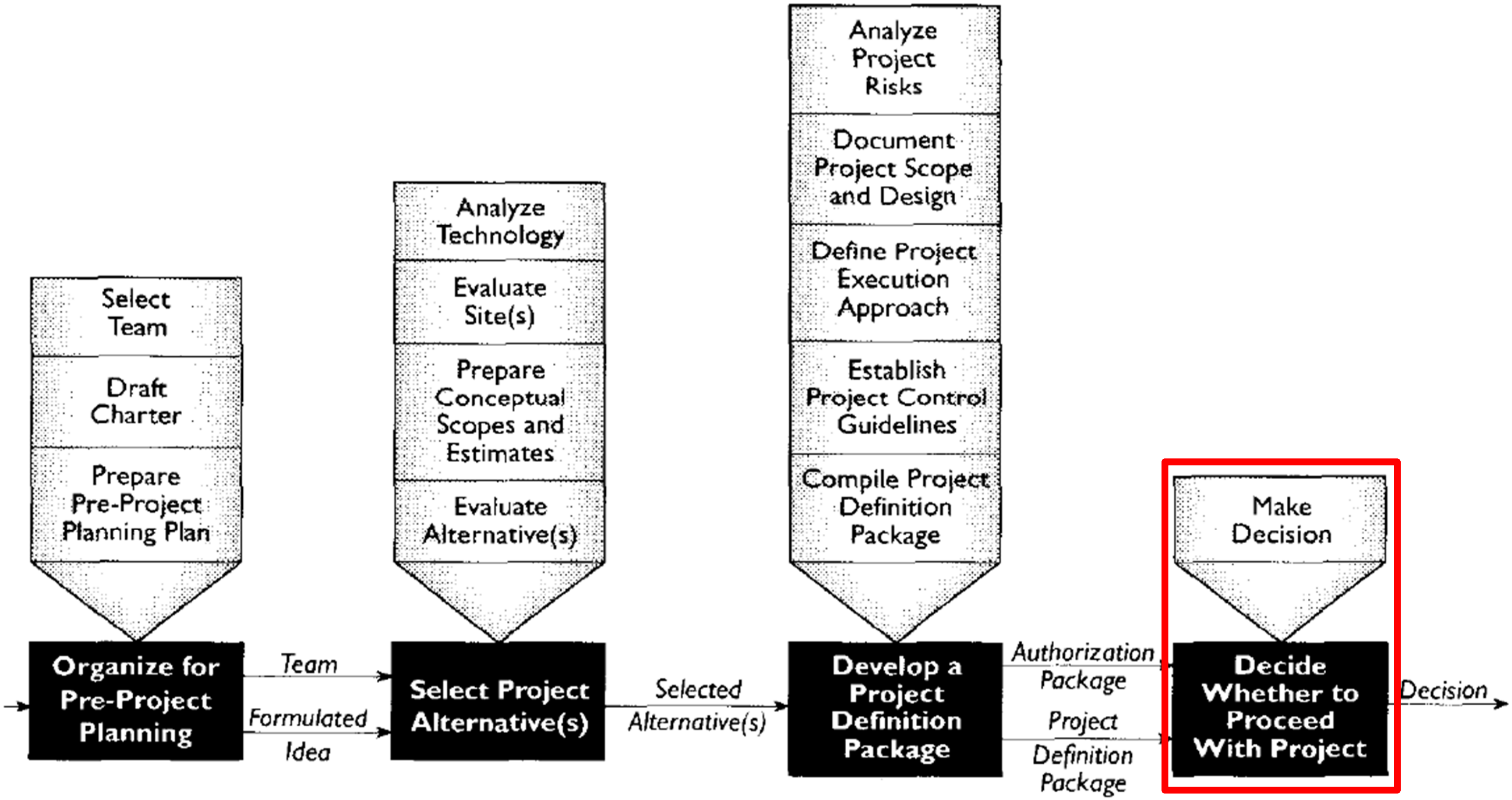
	Tasks	Budget (Total $93 million)	
		%	$ (million)
1	Pre-project planning	5	8
2	Engineering	10	16
3	Procurement	20	32
4	Construction, Commissioning, & Start up	65	104
	TOTAL	100	160

- **Status reporting items**
  - Overall project schedule showing progress and forecast
  - Cumulative cost statement including expenditures, commitments, trends and estimated to complete
  - Design progress and cost
  - Purchasing and delivery status
  - Safety report
  - Major contract report
  - Permit status report
  - Critical needs including decisions reached

(3) Develop a Project Definition Package

- **Compile Project Definition Package**
  - Project Definition Package (PDP)
    - Package prepared for ***execution*** (a detailed roadmap)
    - All previous data including project objectives, alternatives, risk analysis, cost estimate, future obligations
  - Project Authorization Package (PAP)
    - Executive summary for project authorization approval
    - Package prepared for ***decision makers***

(4) Make Decision



(4) Make Decision

- **Make Decision**
  - Project must align with the business needs and the objectives
  - Requires commitment to plan
- **What information will the CEO use?**
  - Business needs
  - Risk
  - Execution approach
  - Decision time – is everyone committed?
  - Lack of consistent views

Measuring PPP (PDRI)

- **Project Definition Rating Index (PDRI)**
  - Simple, easy-to-use tool for measuring the degree of scope development
  - 3 sections, 15 Categories, 70 Elements
    - Section I: Basis of project decision
    - Section II: Basis of design
    - Section III: Execution approach
  - How does the PDRI work?
    - Rate each of the 70 elements to obtain a project definition score of up to 1,000 points
    - Lower score = Better scope definition

Measuring PPP (PDRI)

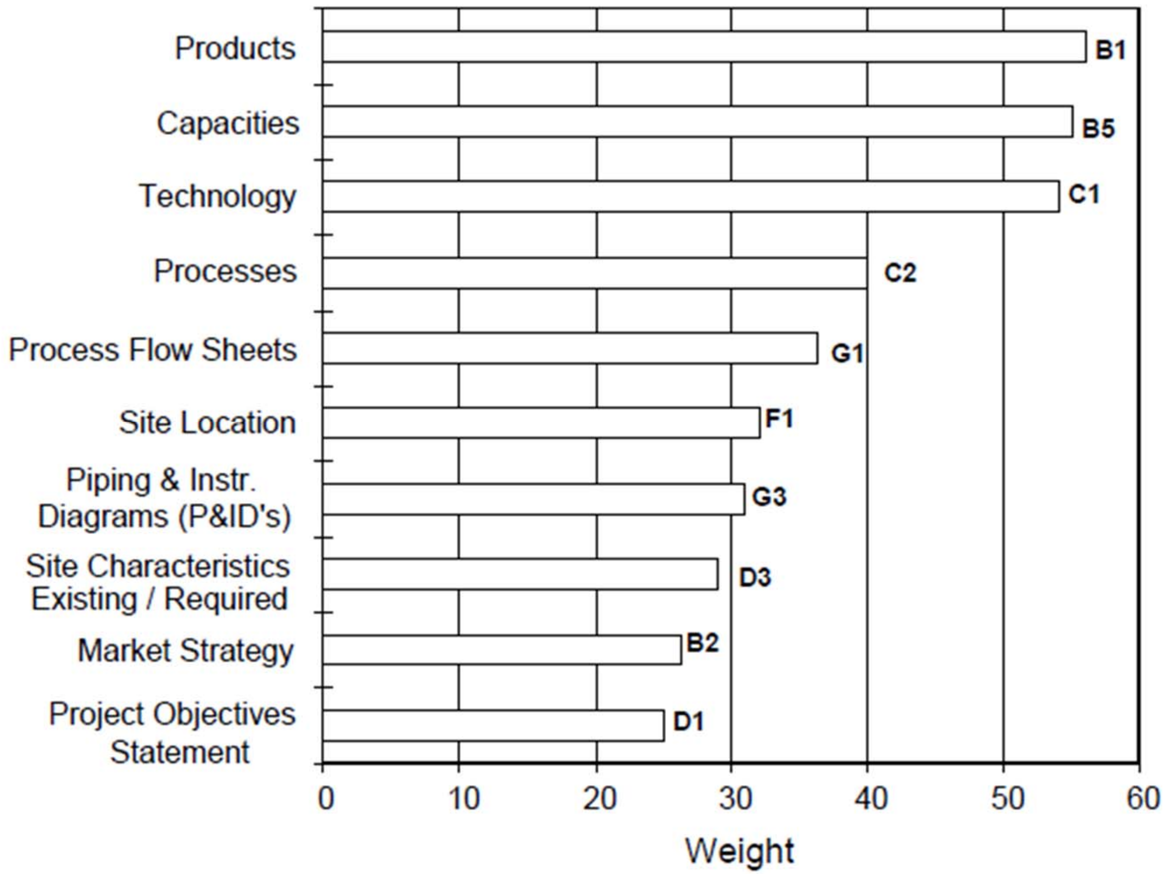
- **Project Definition Rating Index (PDRI)**
  - How was it developed?
    - By G. Edward Gibson
    - CII Research Team 39 at the University of Texas, Austin
    - Used scope development package from 14 companies
    - Brainstorming, affinity diagramming
    - Workshop of project managers and estimators

Measuring PPP (PDRI)

- **Project Definition Rating Index (PDRI)**
  - All 70 elements not equally important (different weights)
  - 54 project managers and estimators from 31 companies
  - Top 10 Elements:

Projects With PDRI Scores Above and Below 200

	PDRI Score		
Performance	**< 200**	**> 200**	**△**
Cost	-5%	+14%	19%
Schedule	-1%	+12%	13%
Change Orders	+2%	+8%	6%
	(N=20)	(N=20)	



Measuring PPP (PDRI)

- **Benefits**
  - Checklist
  - Standardized scope definition terminology
  - Risk assessment
  - Monitor progress
  - Communication and promotes alignment
  - Reconcile differences
  - Training tool
  - Benchmarking tool

Measuring PPP (PDRI)

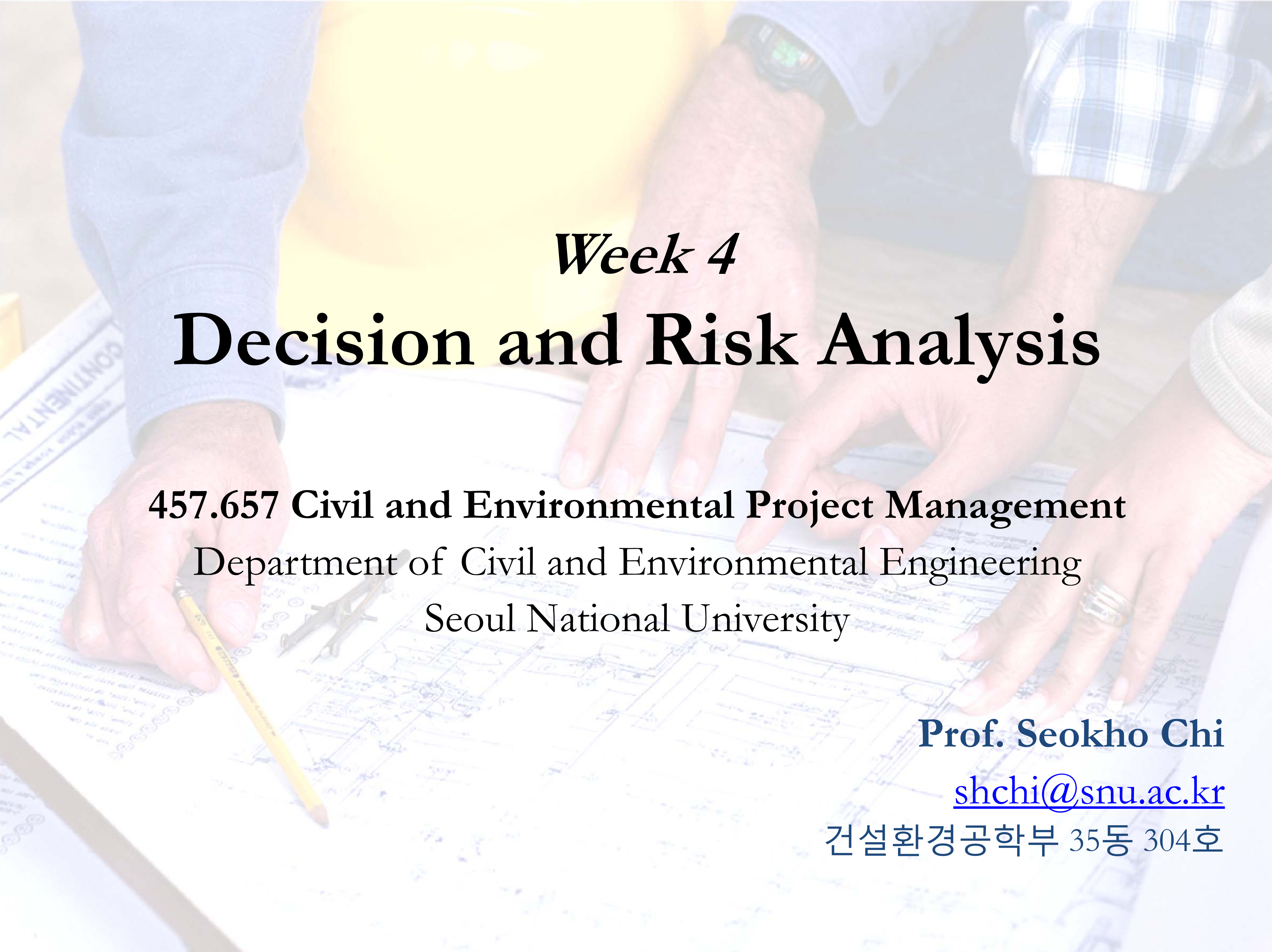
- **Instructions for Scoring**
  - Start for each element (example)
  - Fill empty (example) and complete the total categories (example)

Measuring PPP (PDRI)

- **Instructions for Scoring**
  - The maximum score possible is 1000 (poor) and the minimum is 70 (good)
  - A total PDRI score of 200 or less improves a project's chances of successful performance
  - Hence, each category should strive for a category score that is 20% or less of the maximum category score
  - Take actions for low-level definition elements and continuously monitor to achieve a project goal

Measuring PPP (PDRI)

Project Assessment Session Action Items, June 22, 200x (Sorted in order of PDRI element)						
Item #	PDRI Element(s)	Level of Definition	PDRI Element Score	Item Description	Date Completed	Responsible
1	A2	2	3	Resolve recycle maintenance philosophy issues	July 1, 200x	John Ramos
2	B4	1	1	Issue affordability/feasibility report to the team	July 1, 200x	Jake Blinn
3	B5	1	2	Confirm distribution for finished product	July 1, 200x	Sue Howard
4	F2	2	4	Complete soil testing for duct work	July 15, 200x	Jose Garcia
5	F4	1	1	Monitor all open permits	Ongoing	Jake Blinn
6	G9	3	9	Waste gas, water treatment, HVAC, and misc. balance of plant mechanical equipment list	July 31, 200x	Tina Towne
				And so on.....		



Week 4

Decision and Risk Analysis

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What is Risk?

- **Dictionary Definition**
  - To Expose to the Chance of Injury or Loss (Oxford English Dictionary, 2012)
  - Possibility of Undesirable Outcomes
- **Similar concepts:** bad consequence, loss, crisis, uncertainty?
- **Common Usage**
  - "Risk" is referring exclusively to negative effects
  - "Uncertainty" includes both upside and downside
- **Definition of PMBoK®** (*the Guide to the Project Management Body of Knowledge*, PMI, 4th Ed., 2008)

  "Project risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective … Project risk includes both threats to the project's objectives and opportunities on those objectives."

Decision and Risk Analysis

- **What is decision and risk analysis?**
  - *Formal method* for understanding & *modeling* a decision environment
    - Method for making "more aware" decisions
    - Approach for minimizing *expected losses* or maximizing *expected gains*

Why is Risk Analysis important?

- 리스크 또는 미래에 닥칠 불확실한 사건에 대한 인간의 판단은 다음과 같은 인식적인 편견으로 인해 판단에 한계를 가진다고 함
  - Availability (경험, 정보, …)
  - Representativeness (S건설, 공대생, …)
  - Anchoring and Adjusting (기준을 근거로 보정, 판매량, 케이블, …)
  - Overconfidence (일기예보원, 판매원, 수주실적, …)
  - Wishful thinking
  - Loss aversion, ……….

지금까지 밝혀진 편견의 종류가 약 80여 종류에 달함

(Cognitive Psychology, Sternberg & Mio, 2008)

Why is Risk Analysis important?

- **Risk is an integral part of all Decisions made in the real world.**
  - 대부분의 의사결정 상황은 불확실한 리스크와 관계되어 일어나는데,
  - 이 때, 리스크에 대한 판단의 왜곡 현상이 생기게 되어 의사결정의 방향에 영향을 미침
  - 또한, 인간의 두뇌는 일정량 이상의 정보를 처리하는데 한계가 있음

  - 따라서, 좋은 의사결정을 하기 위해서는 판단의 왜곡현상을 줄이는 과정과
  - 의사결정 상황과 관련된 정보/조건들을 정리하는 과정이 필수적임

  - 이를 위해 **문제를 분해하고 구조화하는 과정이 요구**됨

Why are Decisions Hard?

- Dynamic and Complex Process
- Uncertainty/Risk of Key Elements

- Multiple Options/Alternatives
- Multiple Objectives
- Decisions Linked to Other Decisions

- Different Perspectives/Stakeholders – Multiple decision makers
- Sensitivity/Instability

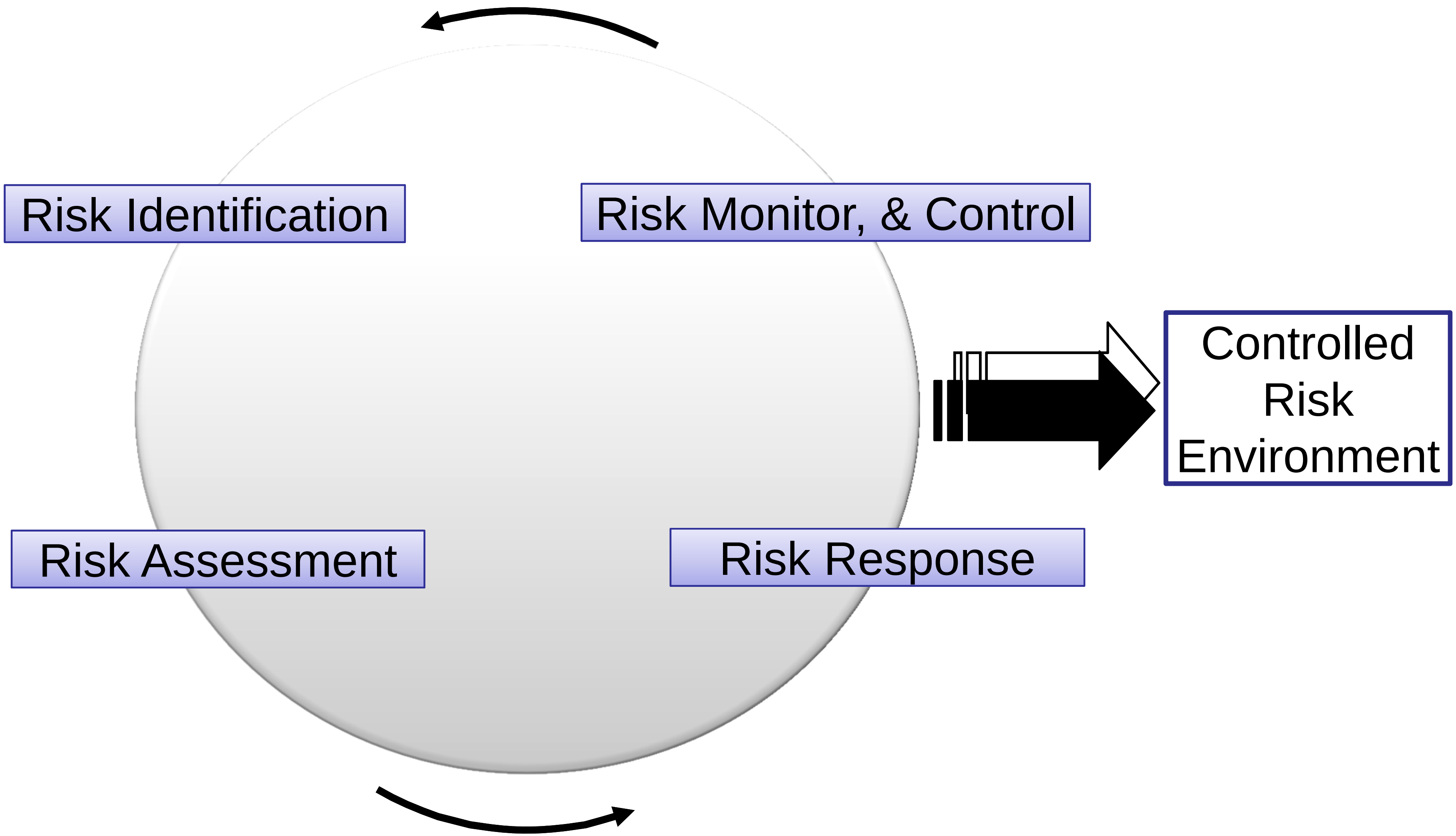
Decision and Risk Analysis

- **Examples of difficult decisions**
  - Project selection/priorities
  - Quantify project's economic risks
  - Project location selection
    - Use corridor A or B for the new freeway?
  - Technology selection
    - Operations, maintenance, construction
    - Segmental or conventional bridge construction technology?

Decision and Risk Analysis

- **Examples of difficult decisions (Cont'd)**
  - Selection of project strategies
    - e.g., J-V, design-build, incentives, performance spec, …
    - Owner's in-house engineering staff or a design consultant
    - Break up a very large project into multiple contracts?
  - Project timing
    - Start date? Duration? Sequence? ….
  - Shut down a "problem job" and replace the contractor?
  - Use extreme amounts of overtime or two shifts to catch up on project schedule?
  - Quantify benefit/cost of insurance

Risk Management Process



Typical Project Risks (PMBoK®, 2008)

- **Contract type**
  - Lump Sum, Unit Price, Reimbursable
- **Unfair contract clauses**
  - Differing site condition, damage for delay, force majeure loss, quantity variation
- **Area factors**
  - Geography, altitude, government stability, local attitude, communications, infrastructure
- **Site factors**
  - Access, congestion, hazard for safety & health, availability of utilities, security
- **Weather**
  - Potential for extremes
- **Monetary**
  - Escalation, exchange rate, cost and award, payment float, retention, overhead cost, penalties

Typical Project Risks (PMBoK®, 2008)

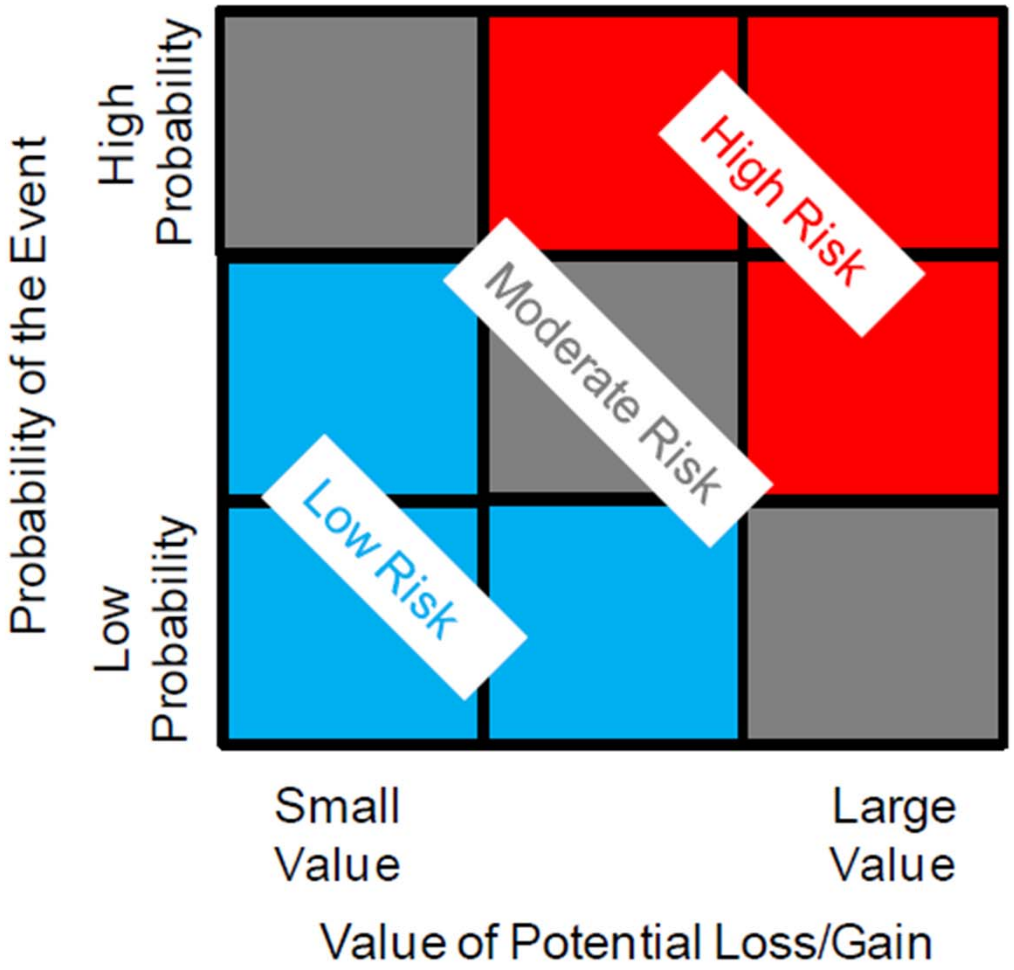
- **Ability to perform**
  - Familiarity with type work, qualification of key personnel, quality of design, requirement of new technology, knowledge of area, need for work
- **Time factors**
  - Deadline and milestones, available work days, potential for stoppage
- **Regulatory factors**
  - Permits, environmental violation
- **Labor factors**
  - Availability, skill, productivity, wage scale, potential for adverse activity
- **Client factors**
  - Financial stability, interference, change management policy, quality expectations, interpretation of contract

Typical Project Risks (PMBoK®, 2008)

- **Material factors**
  - Quantity variation, quality, price, availability, delivery uncertainty, waste in use, potential for theft/damage
- **Equipment factors**
  - Availability, cost, loss or damage
- **Subcontractor/vendor factors**
  - Technical qualification, financial stability, reliability
- **Special exposures**
  - Insurance deductibles, client claim, third party litigation, warrantee & guarantee

Risk Assessment

Risk = *f* (Probability of event, Value of Potential Loss/Gain)



Objective of Risk Response

Frequency			
High		Highest priority	Still in business?
Mod.			
Low	Lowest priority	Can you purchase insurance?	
	Low	Mod.	High **Severity**

Risk Response

- **Proactive Prevention**
  - Focus is on prevention, Preferred, most cost-effective approach
  - Plan, then implement now

- **4Ts**
  - Transfer: **risk sharing** via contracts(negotiation), joint venture, incentives, insurance, bonds, liquidated damages, warranties, working day contract(disaster, severe weather), …
  - Treat: **risk reduction** via training, constructability, antitheft devices, sprinkler systems, ...
  - Take: **risk acceptance** with contingency, …
  - Terminate: **risk avoidance**: don’t participate(problems of hazardous waste, political, financial, etc.), use only proven technologies, …

Texagon Management Inc.
Project Management
Dr. G. Edward Gibson, Jr.
9/28/2004

Risk Management Register for Navy Barracks / Great Lake Training Project								
	PDRI Sections	Issue	Schedule	Cost	Impact	Mitigation	Who	When
1	A5: Facility Requirements D4:Government Regulatory Requirements	Building/EPA Permit acquisitions	H	L	Cannot start entire job	1) Improvement needed on Pre-Project Planning. 2) Need better work on front end and better job addressing	Project Manager	Before construction phase
2	F4: Mechanical Design G3: Equipment Utility Requirements	Design problems: Valve, mechanical and galley equipment access	M	H (< 5% of Project cost)	1) Useless utilities 2) Maintenance problems	1) To be addressed in design time-out by designers. 2) Do monthly walk-through and status updates	Design Manager	During design phase
3	B4: Design Philosophy	Entire design review process and its documentation of comments.	M	L	Hard to make good progress and alignment	1) A team design review meeting. 2) Work the timeliness of receiving the comments and the quality of the review.	Design Manager	Before design review and construction phase
4	L2: Owner Approval Requirement	Occasional delays in resolving change orders and customer changes late into construction	M	M	Rework and cost more	1) Pay more attention on completing the paperwork 2) Fix through design review process. 3) When personnel turnover occurs, enforce the previous decisions to avoid late changes	Project Manager Construction Manager Design Manager	Throughout project life
5	K: Project Control	Severe winter work conditions	H	H (< 5% of Project cost)	Delay and less productivity	1) Development of Heating plan 2)Thawing out the frost lines	Construction Manager	During construction phase
6	K5: Safety Procedures	Construction safety	H	H (< 5% of Project cost)	Accidents can stop the project	1) Monthly recognition with tangible awards 2) Subcontractor's participation	Project Team	Throughout project life
7	J2: Documentation/Deliverables	Delay in submittals by A-E designers	M	L	1) We cannot start each sections 2) Delay of the entire work	Increase design team's capacity	Design Manager	Throughout project life
8	K1: Project Quality Assurance and Control	Air emission standards when boiler operates with back up fuel	L	L	Bad to environment	1) Raise plant boiler stack height 2) Use very low sulfur content fuel	Design Manager Project Controls Manager	During design and operation phase
9	D1: Site Layout	Utility system coordination : Choosing best locations for grease traps and transformers	L	L	Maintenance Issues	1) Coordinate utility distribution more closely 2) Special co-ordination meeting	Design Manager Construction Manager	Throughout design phase
10	J2: Documentation/Deliverables	Completion of As-builts	L	L	Operations and maintenance issues	Ensure they are compiled and issued	Design manager Construction Manager	Project Completion

Legend > H : High Impact
> M : Medium Impact
> L : Low Impact

Risk Identification and Assessment

- **Objective Function**
  - What would be a more strategic, structured way for criteria and weights setting and assessing risks?
  - Become the basis for decision making
  - Explain what we are trying to achieve better

  - Formula-based support: Outcomes + Decision Criteria
  - Outcomes: What are the consequences of decisions and related events? (advantages and disadvantages)
  - Decision criteria: What are the measures of goodness or preference

Objective Function Practice (1)

- Modularization/Preassembly (off-site manufacturing) → GO or NO GO

Objective Functions – Example (1)

- **Modularization/Preassembly Go/No Go**
- **Possible Objective Function:**
  - Potential Total Value to Owner =

    (1) Potential Project Net Savings +

    (2) Potential Gross Revenue from Early Completion & Sales

where, *Potential Project Net Savings* =

Direct labor savings + Savings from reduced project duration + Scaffolding savings

– Additional engineering cost – Additional material cost

– Additional transport cost – Additional indirect cost

– Additional rework cost

Objective Functions – Example (2)

- **Son-La dam construction in Vietnam: Go/No Go**
  - Vietnam is experiencing a more rapid rise in demand for electricity than economic growth.
  - Vietnam's energy demand heavily relies on coal fired generating plant
  - Vietnam government is deciding whether or not to do the great hydro expansion.
  - Son-La Dam will be the biggest project in this hydro expansion

Objective Functions – Example (2)

- Son-La dam construction in Vietnam: Go/No Go

Decisions need to be made?

The Son-La Dam project: Go/No Go

Decision Maker? A Vietnam government agency

Objective Functions – Example (2)

- **Son-La dam construction in Vietnam: Go/No Go**

Normal Water Level	265 m
Dam Height	177 m
Volume of Reservoir	25.4 billion m^3
Surface of Reservoir	440 km^2
Installment Capacity	3,600 MW
Energy Production	14,124 GWh/year
Project Estimated Cost	$2.3 billion
Project Life Cycle	100 years

Objective Functions – Example (2)

- **Positive Impacts**
  - Energy production: 14,124 GWh/year
  - Economic benefit
    - New opportunity for regional socio-economic development
    - Revitalize the economy of north-eastern region of Vietnam
  - Water supply for production
  - Regulation flood stream
  - Reducing air pollution and carbon dioxide emissions
  - Opportunity for recreation and tourism

Objective Functions – Example (2)

- **Negative Impacts**
  - Social impacts
    - Inundation areas: 40,500 ha (Agriculture land: 9,650 ha, Forestry land: 3,900 ha)
    - People to be resettled: 95,600
    - Cost for resettlement: $700 million
    - Loss of infrastructures: Houses (1,600,000m^2) and Roads (300km)
  - Environmental impacts
    - Ecological and hydrologic impacts
    - Loss of biodiversity
  - Dam safety issues
    - Serious threats from earthquake
    - Construction quality issues from workmanship

Objective Functions – Example (2)

- ## Decision Criteria

- **Final Criteria**
  - **Return on Investment**
    - **Benefits**
      - Annual savings
      - Local economy revitalization
      - More job market and opportunities
      - Local city growth
      - Improvement of fluvial navigation
      - Recreation and tourism
      - Water supply
    - **Costs**
      - Massive construction cost
      - Compensation and resettlement
      - Commission for Russian tech.
      - Submerged agriculture land
      - Operation and maintenance cost
      - Productivity changes of estuaries
      - Earthquake prevention
  - **Optimize Environmental Issues**
    - **Environmental Issues**
      - Regulation flood stream
      - Improvement of microclimate
      - Reduce air pollution
      - Impact on local fauna and flora
      - Ecological impacts
      - Hydrologic impacts
      - Loss of mineral resources
  - **Optimize Safety**
    - **Safety**
      - Forests near reservoir
      - Earthquake zone
      - Capability of Vietnamese
      - Construction safety & security
  - **Minimize Conflict**
    - **Social Impacts**
      - Ethnic minorities resettlement
      - Loss of agriculture land
      - Loss of historic architecture
      - Water-related diseases (Health)
    - **Political Issues**
      - Political nego. with China
      - Economic nego. with China
      - Break-up & breach of obligation
      - Political dissension during construction
      - Tax rate for construction cost
    - **Cultural Concerns**
      - Cultural difference
      - Language barrier
      - Different laws, standards, and regulations

Objective Functions – Example (2)

- **Weighting Four Major Criteria**
  - Analytic Hierarchy Process (AHP) method
    - Compare the major categories in pair-wise fashion, ranking each pair on a scale of 1 to 5 according to the criteria:
      - 1: The two factors contribute equally
      - 2: One factor is slightly favored over the other
      - 3: One factor is moderately favored over the other
      - 4: One factor is strongly favored over the other
      - 5: One factor dominates

Objective Functions – Example (2)

- **Weighting Four Major Criteria**
  - Analytic Hierarchy Process (AHP) method

A \ B	Return on Investment	Optimize Safety	Minimize Conflicts	Optimize Environment
Return on Investment	**1 (contribute equally)**	**2 (A slightly favored over B)**	**2**	**3 (moderately favored)**
Optimize Safety	0.5	1	**1.2**	**2**
Minimize Conflicts	0.5	0.83	1	**2**
Optimize Environment	0.33	0.5	0.5	1
Sum	2.33	4.3	4.7	8

Objective Functions – Example (2)

- **Normalized Weighting Four Major Criteria**
  - Analytic Hierarchy Process (AHP) method

	Return on Investment	Optimize Safety	Minimize Conflicts	Optimize Environment	Row Sum	Average
Return on Investment	0.43 (1/2.33)	0.47	0.43	0.38	**1.69**	**0.42**
Optimize Safety	0.21 (0.5/2.33)	0.23	0.26	0.25	**0.95**	**0.24**
Minimize Conflicts	0.21 (0.5/2.33)	0.19	0.21	0.25	**0.86**	**0.22**
Optimize Environment	0.14 (0.33/2.33)	0.12	0.11	0.13	**0.49**	**0.12**
Sum	1	1	1	1	**4**	**1**

Objective Function

*= 0.42*Return on Investment + 0.24*Optimize Safety*

*+ 0.22*Minimize Conflicts + 0.12*Optimize Environmental Issues*

Group Assignment Exercise

The U.S. Navy plans to design and construct two new recruit barracks to replace the old ones built between the years of 1958 and 1966, located at Naval Station Great Lakes, Illinois. This movement is a part of the RTC RECAP project, transforming Boot Camp from a deficient, facility-centric base into a state-of-the-art, training-centric environment. The entire project includes the development of the complete infrastructure (roads, sidewalks, utilities, storm drainage, elevated water tank, railroad underpass, landscaping, etc.) for a 48-acre parcel of land, adjacent to the existing RTC campus. Additional incidental related work must also be considered to provide a complete and useable facility. Each barrack will measure 16,700 square meters and will provide open bay housing for 1,100 recruits, classrooms, and advanced food service and dining facility. The total estimate cost is approximately $80 million including two barrack (each $30 million) facilities and green land development.

Group Assignment Exercise

- **PDRI for risk assessment, *What would be possible risks?***
  - Example of risk register
- **Conceptual estimate and impact of cost-related risk issues**
  - Conceptual estimate
    - The total estimate cost is approximated $80 million, including $60 million for two barrack facilities and $20 million for green land development such as site earthmoving work, road construction, building water and power supply facilities, etc. Former experience shows one barrack facility with the same size costs $30 million. Although the cost of land development may vary depending on the actual work quantity, it is our best estimated based on the current information.

Group Assignment Exercise

- **Conceptual estimate and impact of cost-related risk issues**
  - Risk analysis
    - Regarding PDRI building sections, ten high risk issues that have the potential impacts on cost have been identified. These issues are addressed in risk management register. Among the ten high risk issues, the following three rank top three:
      - Designing problems: Valve, mechanical, and galley equipment access
      - Severe winter work condition
      - Construction safety

Group Assignment Exercise

Risk analysis (Cont'd)

First, considering this is a public work, construction safety is the primary concern of all stakeholders. The consequence of safety problem is critical. No one serving for the government wants to make problems resulting from safety such as incidents and delay of work. The potential cost due to this issue have a large range depending on the specific problems occurred. Insurance should be purchased for worker compensation.

Secondly, based on the characteristics of this project and past experience, it is found that valve, mechanical, and galley equipment access play an important role in our facility. Designing problems of changing them, therefore, have heavy impacts on the schedule as well as the cost of the whole project.

Group Assignment Exercise

Risk analysis (Cont'd)

Typically the cost of valve, mechanical, and galley equipment access is approximately 20-30 percent of the total cost. With thorough consideration, the cost impact caused by this could be limited to 5 percent of the total cost (i.e., $4 million).

Finally, although sever winter work condition is very normal in Chicago, unexpected severe weather may be encountered, resulting to work delay in large scale. This has to be carefully studied and monitored during construction. The impact of this issues is also restricted to about 5 percent the total cost (i.e., $4 million), considering possible 1 month or less project delay among the total 18-month project duration.