SCHEDULING TOOLS IMPROVEMENT IN COMPLEX PROJECT MANAGEMENT

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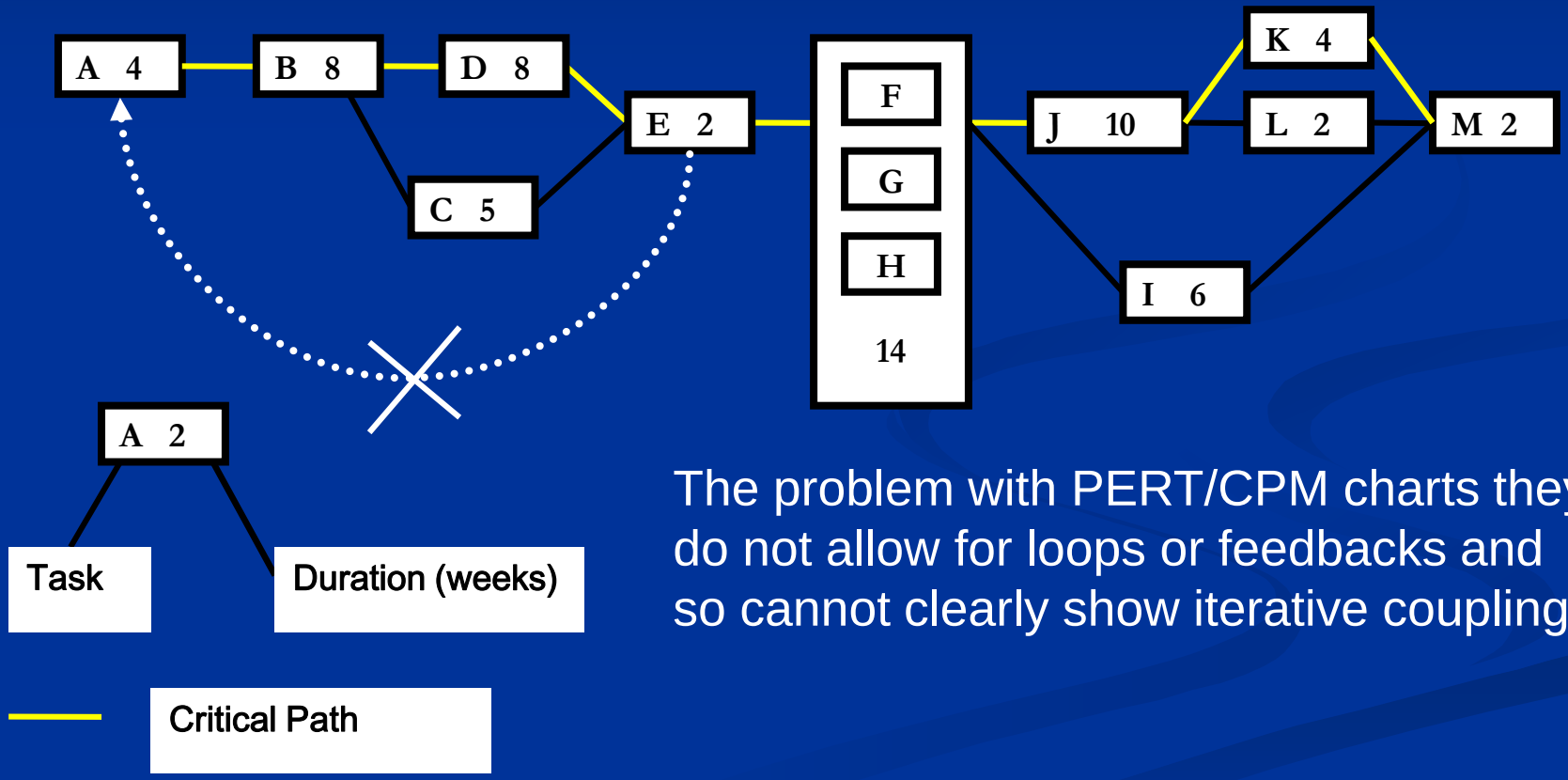
Outline

- Traditional Project Scheduling Techniques (Gantt Chart, CPM, PERT)
- Task Dependencies
- Design Structure Matrix (DSM): Lay out, interpretation and data types
- Case study

Gantt Chart

- Normally used for representing the timing of tasks
- It does not clearly display the dependencies among tasks and do not fully determine the timing of the tasks
- The problem with Gantt chart when two tasks overlap in time it can be misleading whether the tasks are in parallel, sequential or iteratively coupled.

CPM/PERT



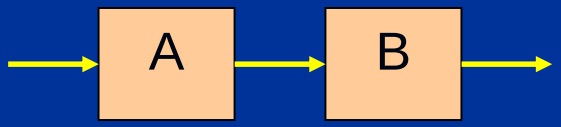
The problem with PERT/CPM charts they do not allow for loops or feedbacks and so cannot clearly show iterative coupling

- Traditional project scheduling techniques such as Gantt chart, CPM and PERT allow the modelling of sequential and parallel processes in projects, but they fail to address interdependency feedbacks and iterations.

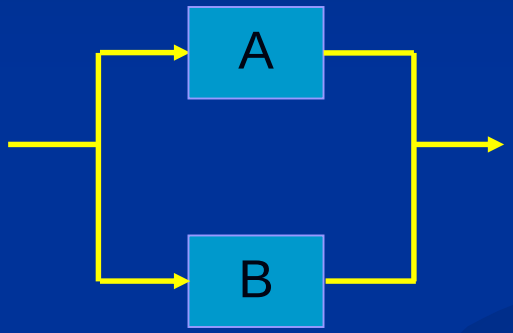
- A method to account for feedback and iterations, a matrix based tool called Design Structure Matrix (DSM) is presented.

Types of Task Dependencies

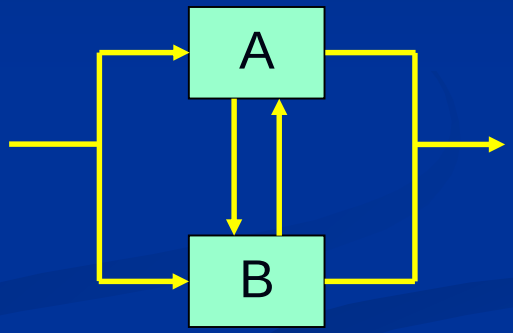
Dependent (Sequential)



Independent (Parallel)

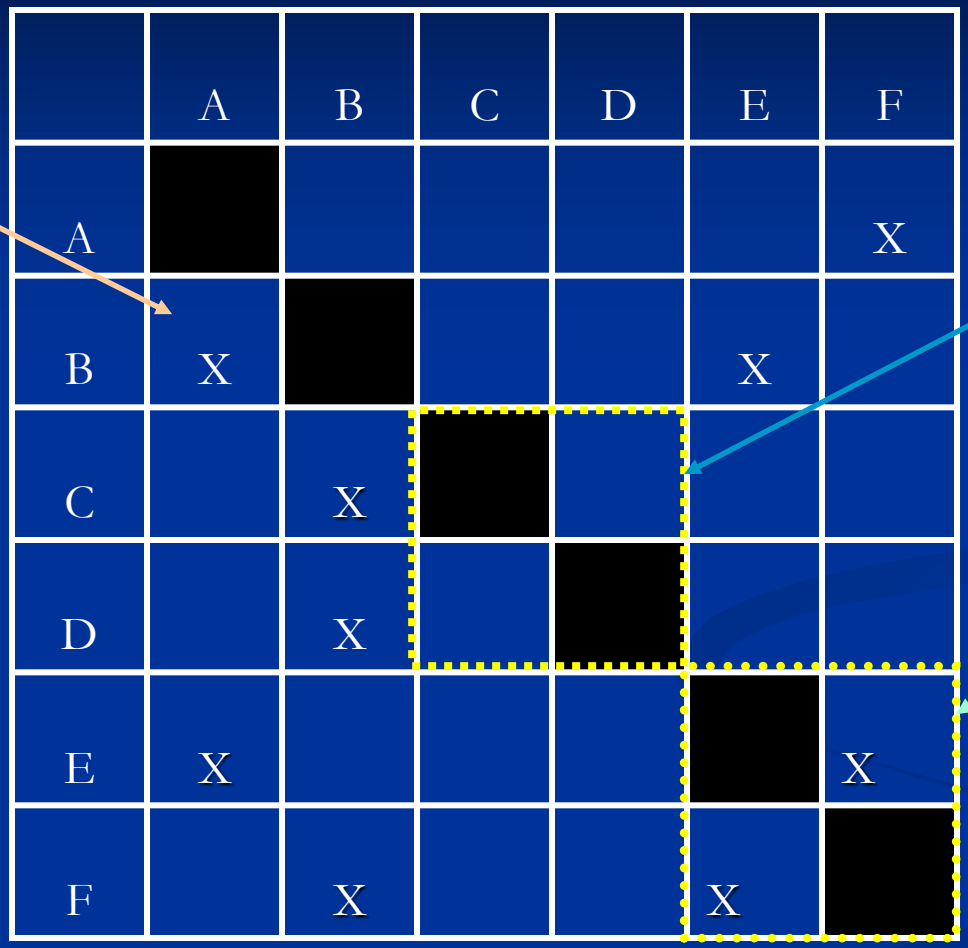


Interdependent (Coupled)



- A Design Structure Matrix (DSM) is a compact, matrix representation of a project.
- The matrix contains a list of all tasks. It shows what information is required to start a certain task and where that information from that task feed into
- It is a project scheduling technique used for representing and analysing dependencies between tasks.

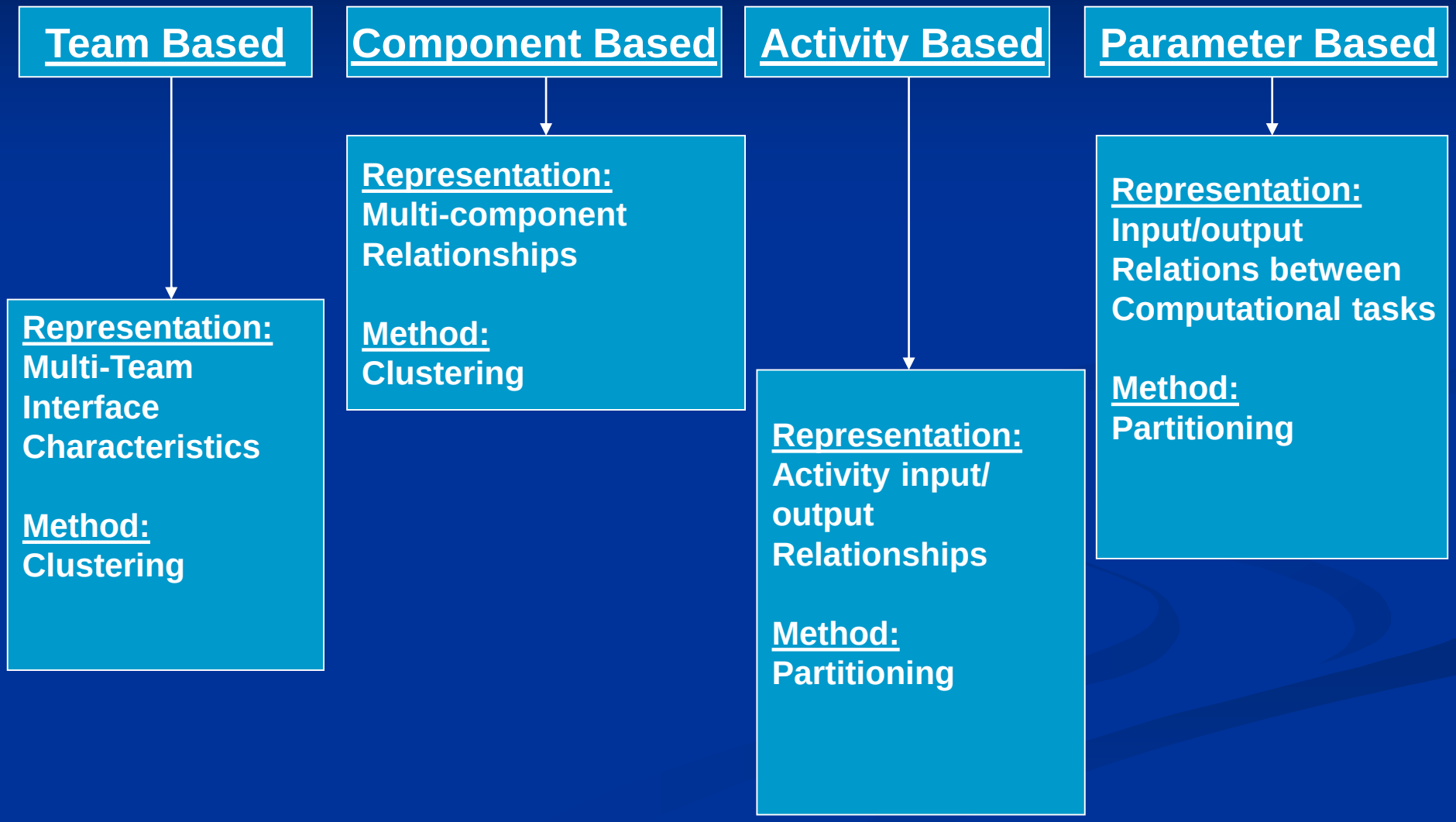
DSM Representation of a Project



The marks below the diagonal indicate *forward flow* of information

The marks above the diagonal indicate a *feedback* from a later activity to an earlier one

DSM Data Types



- Static DSM represents system elements existing simultaneously, such as components of product architecture or groups in an organization.

- In time based DSM, the ordering of the rows and columns indicates a flow through time: upstream activities in a process precede downstream activities.

- Instead of using graphs to represent relationships, a matrix system was developed to provide a systematic mapping among system elements that is clear and easy to read regardless of size.

- Design Structure Matrix is implemented in the following case study: Petroleum Oil Field Development project.

Case Study-Petroleum Oil Field Development (POFD) Project

- Project Duration: 100 days
- This project involves 24 tasks

- The objective of the POFD project is to design a development plan for a new oil field discovered after drilling a number of wells.
- DSM technique is implemented to improve planning, execution and managing the project by reducing the number of feedbacks and the project duration using partitioning and tearing processes.

Constructing the POFD Project in DSM

- We interviewed engineers to determine the inputs and outputs for the list of tasks.

- We input the marks into the matrix

1.1 Review & Prepare Data	3.4 Conduct Geo-mechanical Studies
1.2 Collect Samples	3.5 Conduct Special Core Analysis
1.3 Define Reservoir Rock Types (RRT)	3.6 Do Routine & Special Core Interpretation
1.4 Prepare Data for Static Model	4.1 Input Data (Dynamic model)
2.1 Input Data (Static model)	4.2 Initialize Reservoir Dynamic Model
2.2 Build Reservoir Framework	4.3 Do History Matching
2.3 Build 3D Property Model (s)	4.4 Do Development Predictions
2.4 Manipulate & Rank Models	5.1 Study Existing Data Sources
2.5 Build 3D Flow Simulation Grid (s)	5.2 Collect Samples
3.1 Study Existing Data Sources	5.3 Conduct Standard PVT Study
3.2Conduct Coring	5.4 Conduct Specialized PVT Study
3.3 Conduct Rock Characterization	5.5 Develop PVT Applications

Constructing the POFD Project in DSM

	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	5.1	5.2	5.3	5.4	5.5
1.1															X									
1.2																								
1.3	X	X																						
1.4			X																					
2.1				X											X									
2.2					X																			
2.3				X		X																		
2.4							X																	
2.5								X										X						
3.1																								
3.2																								
3.3			X								X													
3.4											X													
3.5											X													
3.6										X		X	X	X										
4.1									X						X									X
4.2																X								
4.3																	X							
4.4																		X						
5.1																								
5.2																								
5.3																					X			
5.4																					X			
5.5																				X		X	X	

Methodology

Partitioning the DSM (Reachability Matrix)

- This is the process of rearranging the order of tasks in such a way that dependency relationships are brought either close to the diagonal or below the diagonal, changing the DSM into a lower triangular form.
- Fewer elements in the system will be involved in the iteration cycle.
- The outcome would be a faster development process.

Identifying Loops/Circuits

Elements	Input Elements	Output Elements	Intersection	Level
1.1	1.1, 3.6	1.1, 1.3	1.1	
1.2	1.2	1.2, 1.3	1.2	1
1.3	1.1, 1.2, 1.3	1.3, 1.4, 3.3	1.3	
1.4	1.3, 1.4	1.4, 2.1, 2.3	1.4	
2.1	1.4, 2.1, 3.6	2.1, 2.2	2.1	
2.2	2.1, 2.2	2.2, 2.3	2.2	
2.3	1.4, 2.2, 2.3	2.3, 2.4	2.3	
2.4	2.3, 2.4	2.4, 2.5	2.4	
2.5	2.4, 2.5, 4.3	2.5, 4.1	2.5	
3.1	3.1	3.1, 3.6	3.1	1
3.2	3.2	3.2, 3.3, 3.4, 3.5	3.2	1
3.3	1.3, 3.2, 3.3	3.3, 3.6	3.3	
3.4	3.2, 3.4	3.4, 3.6	3.4	
3.5	3.2, 3.5	3.5, 3.6	3.5	
3.6	3.1, 3.3, 3.4, 3.5, 3.6	1.1, 2.1, 3.6, 4.1	3.6	
4.1	2.5, 3.6, 4.1, 5.5	4.1, 4.2	4.1	
4.2	4.1, 4.2	4.2, 4.3	4.2	
4.3	4.2, 4.3	2.5, 4.3, 4.4	4.3	
4.4	4.3, 4.4	4.4	4.4	
5.1	5.1	5.1, 5.5	5.1	1
5.2	5.2	5.2, 5.3, 5.4	5.2	1
5.3	5.2, 5.3	5.3, 5.5	5.3	
5.4	5.2, 5.4	5.4, 5.5	5.4	
5.5	5.1, 5.3, 5.4, 5.5	4.1, 5.5	5.5	

Identifying Loops/Circuits

- We can observe from the column of the input elements that elements 1.2, 3.1, 3.2, 5.1 and 5.2 are in the top level hierarchy because the input values of these elements are equal to the intersection values.

- We will remove these elements from the table and continue until we reach the corresponding input and output values.

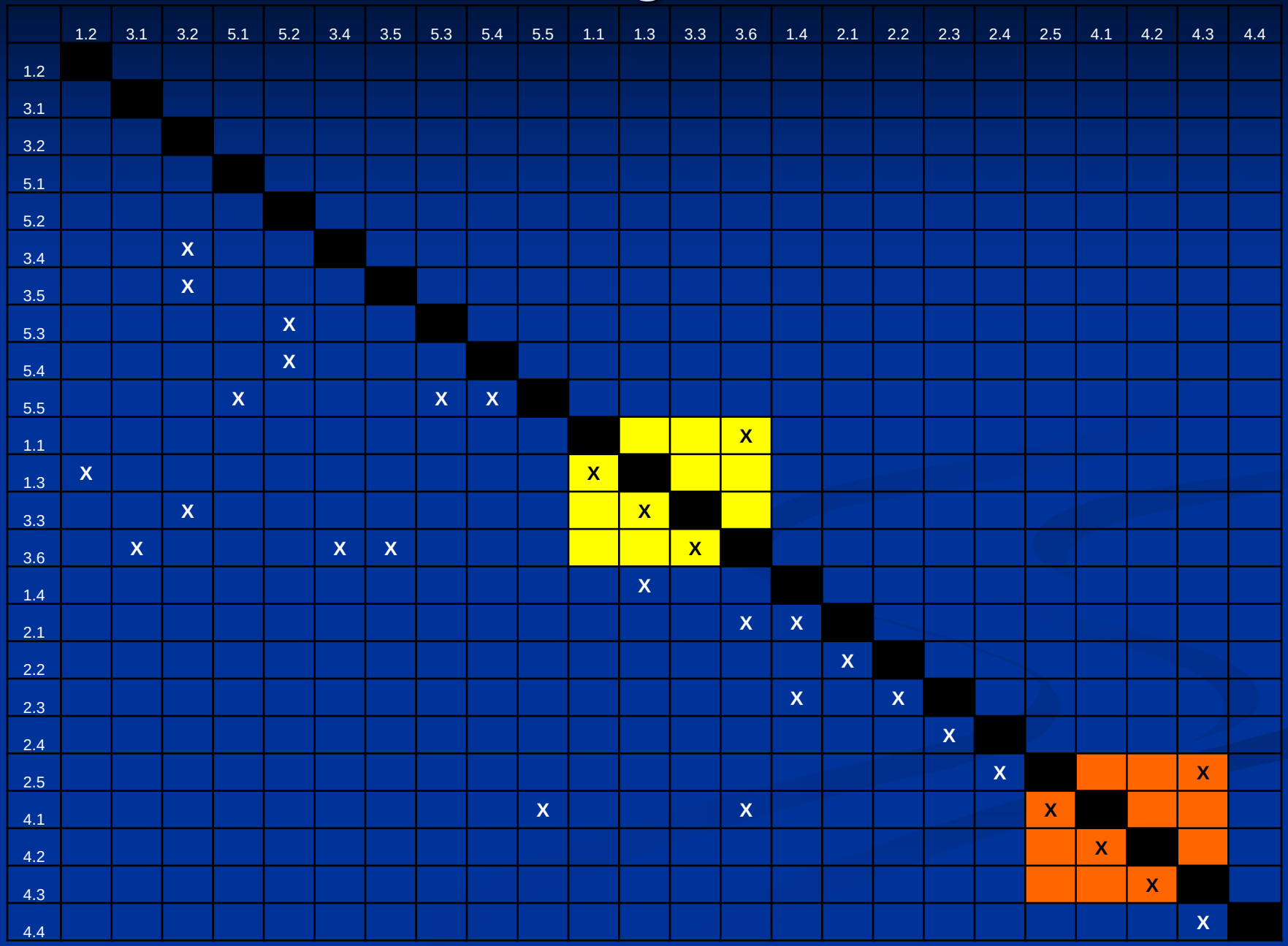
Identifying Loops/Circuits

Elements	Input Elements	Output Elements	Intersection	Level
4.4	4.4	4.4	4.4	11

- We will rearrange the original DSM, and schedule the elements starting with the top level hierarchy through to the 11th level hierarchy elements.

- The circuits we identified will form two blocks in the DSM. The first involves tasks 1.1, 1.3, 3.3, 3.6 and the second block involves tasks 2.5, 4.1, 4.2 and 4.3.

Partitioning the DSM



Tearing the DSM

- This is the process of selecting the set of feedback marks that if removed from the matrix, (and the matrix is re-partitioned) turning the matrix into the lower triangular
- The marks that are removed from the matrix are called “tears”
- Levels of task sensitivity and information variability for each task are derived

Levels of Task Sensitivity

Value	Description	
0	Weak	The information from the input task is irrelevant (trivial information)
1	Low	A major part of the task can be performed without information from the input task (verification information)
2	Medium	The task can be started without complete information from the input, but partial information is necessary
3	High	It is impossible for the task to proceed without complete information from the input task

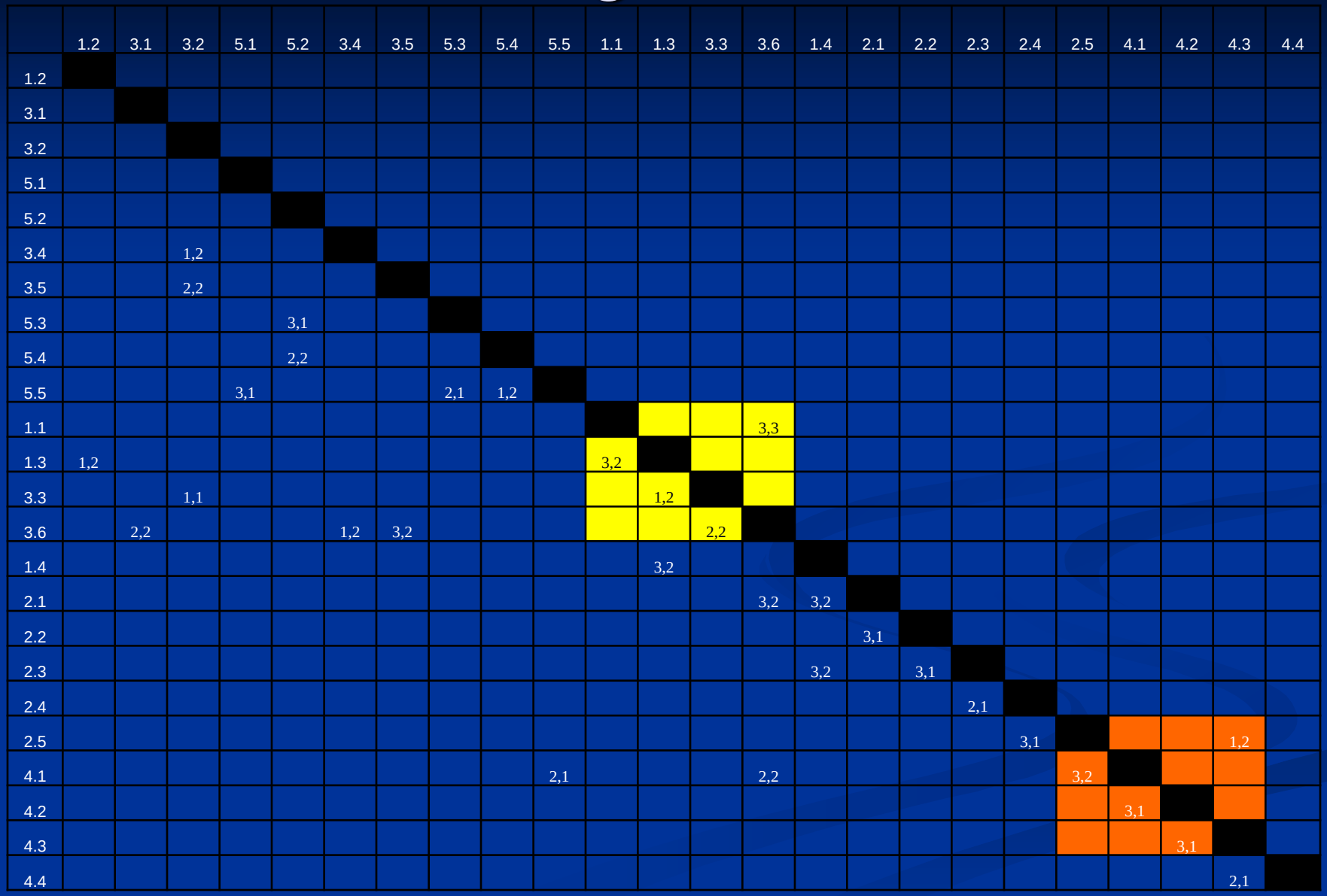
Levels of Information Variability

Value	Description		Likelihood of Change
0	Definite	A relatively certain outcome will result	Very low
1	Stable	An outcome can be identified as highly probably (90% sure)	Low
2	Unknown	A value of intervals can be identified, but there is no way to conclude which value is more likely	Medium to High
3	Unstable	It is not possible to identify any limits on the outcome	Very High

Ranges of Dependency Strength and Their Significance

Dependency Strength	Description
0-2	Dependency is weak Low risk of rework
3-5	Dependency is moderate Moderate risk of rework
6-9	Highly sensitive to change High risk of rework

Tearing the DSM



Tearing the DSM

- Block 1

Task	BIi	BOi	Pi	Rank
1.1	9	6	1.5	-
1.3	6	2	3	-
3.3	2	4	0.5	-
3.6	4	9	0.44	1

- Block 2

Task	BIi	BOi	Pi	Rank
2.5	2	6	0.33	1
4.1	6	3	2	-
4.2	3	3	1	-
4.3	3	2	1.5	-

Tearing the DSM

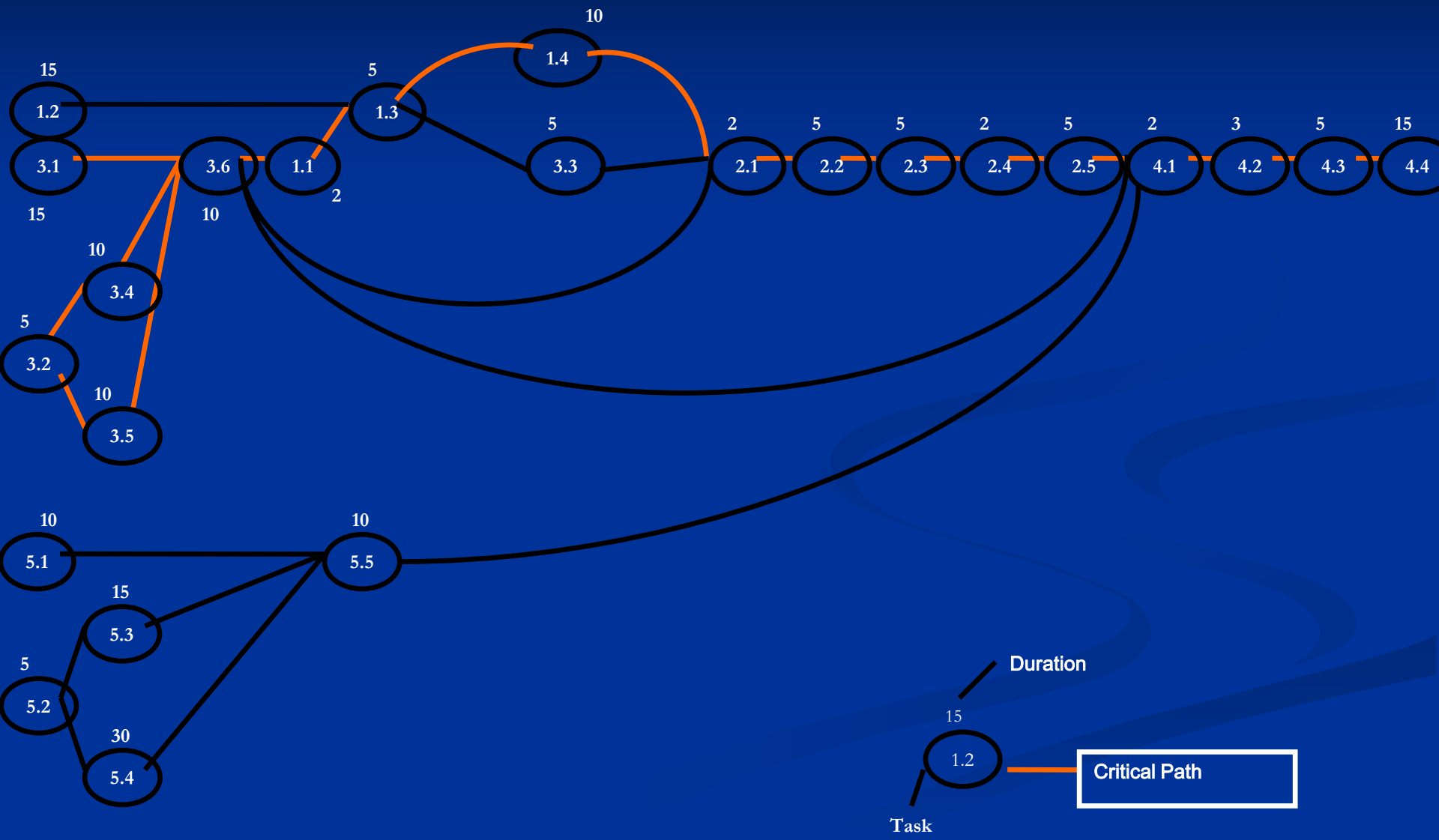
- Therefore task 3.6 is scheduled first within block 1 and task 2.5 is scheduled first within block 2 because they require minimum input and delivers maximum output.

- This results in tearing mark (3.6, 3.3) from block 1 and mark (2.5, 4.3) from block 2, hence turning the DSM into the lower triangular form.

- Since we have reduced all the feedback marks we can apply a traditional project scheduling technique such as CPM to determine the project duration.

- We interviewed engineers to determine the appropriate task duration after reducing all the feedback marks.

CPM Chart of the POFD Project



Conclusions

- DSM technique reduced all of the feedback marks, hence reducing the amount of delay in the project.
- From the CPM chart the project duration now is 86 days. The original duration was 100 days, therefore we have saved 14 working days, hence reducing the total cost of the project.
- The main advantage of the DSM over traditional scheduling techniques is in its compactness and ability to present an organized and efficient mapping among tasks that is clear and easy to read regardless of size.

Thank You