Instructor’s
Title & Name

Course Title….

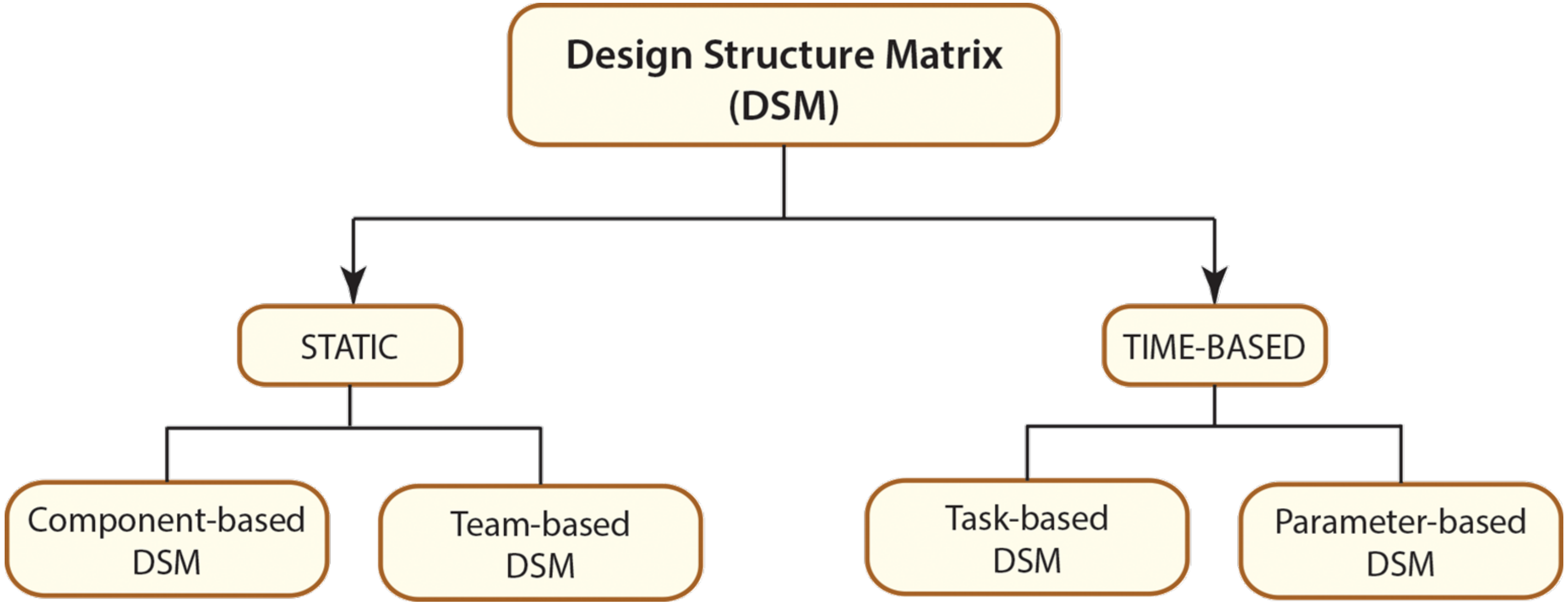
Design Structure Matrix (DSM) is a tool for:

- complex systems management
- product development
- project planning, management, and organizations
- system decomposition and integration

- ❑ Helps project team to agree on the design of a complex product in a timely manner.

- ❑ Helps to design a complex product to be modular, so that portions of it can be more easily changed or modified.

Different DSM Types

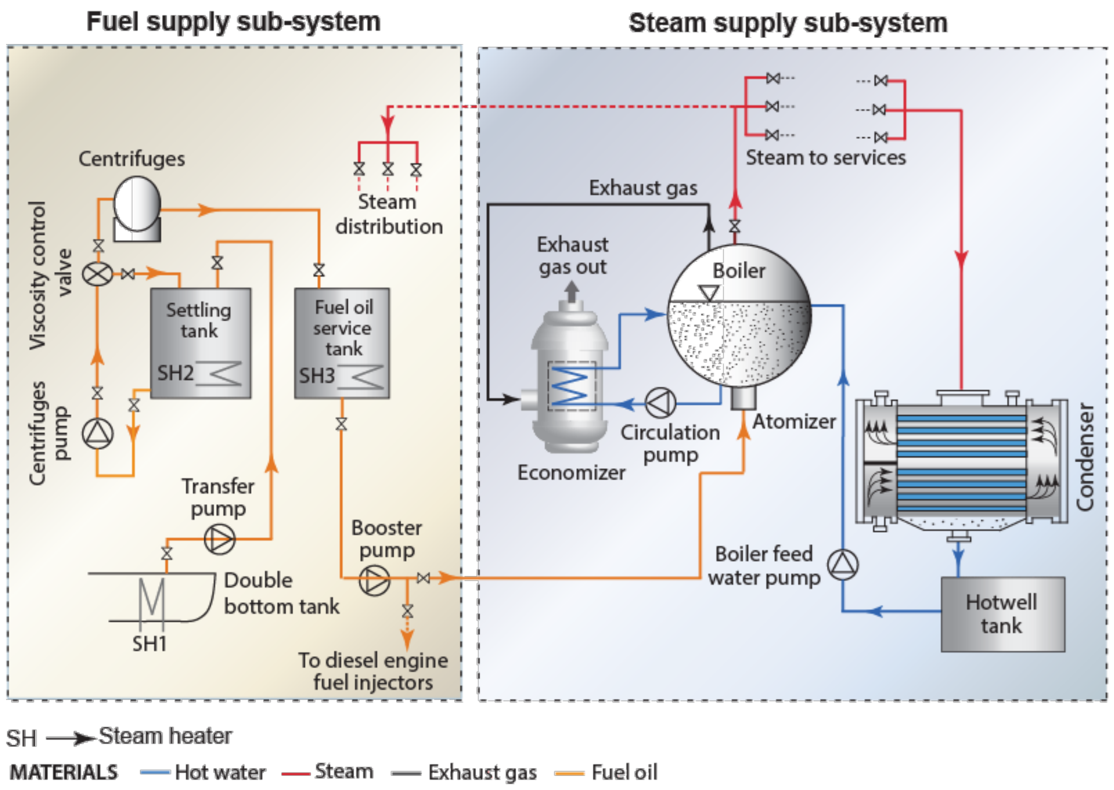


Component-Based DSM

- **Component-based DSM** analyzes relations and interactions among components in complex system architecture. Four types of component grouping is shown in Table 5.1 (Pimmler [4], Tyson [5]).

Table 5.1: System component interaction types (4,5).

Special	Associations of physical space and allignment, needs for adjacency or orientation between two components
Energy	Needs for energy transfer/exchange between two components (e.g., power supply)
Information	Needs for data or signal exchange between two components
Material	Needs for material exchange between two components



As sown in Table 5.2, a quantification arrangement among the components enables weighting interactions relative to each other (Pimmler [4], Tyson [5]).

Table 5.2: Spatial component interaction quantification arrangement (4,5).

(+2)→Required	Physical adjacency is necessary for functionality.
(+1)→Desired	Physical adjacency is beneficial, but not necessary for functionality.
(0)→Indefferent	Physical adjacency does not affect functionality.
(-1)→Undesired	Physical adjacency causes negative effects but does not prevent functionality.
(-2)→Undesired	Physical adjacency must be prevented to achieve functionality.

Team-Based DSM

- **Team-Based DSM:** is used for complex organizational analysis to show interactions and information flow among organizational entities, design teams, and team members. Different types of interaction among the team members are shown in Table 5.3 [6].

Table 5.3: Different types of interaction among the team members.

Level of Detail	Sparse (documents, e-mail) to reach (models, face-to-face).
Frequency	Low (batch, on-time) to high (on-line, real).
Directions	One-way to two-way.
Timing	Early (preliminary, incomplete, partial) to late (final).

Task/Activity-Based DSM

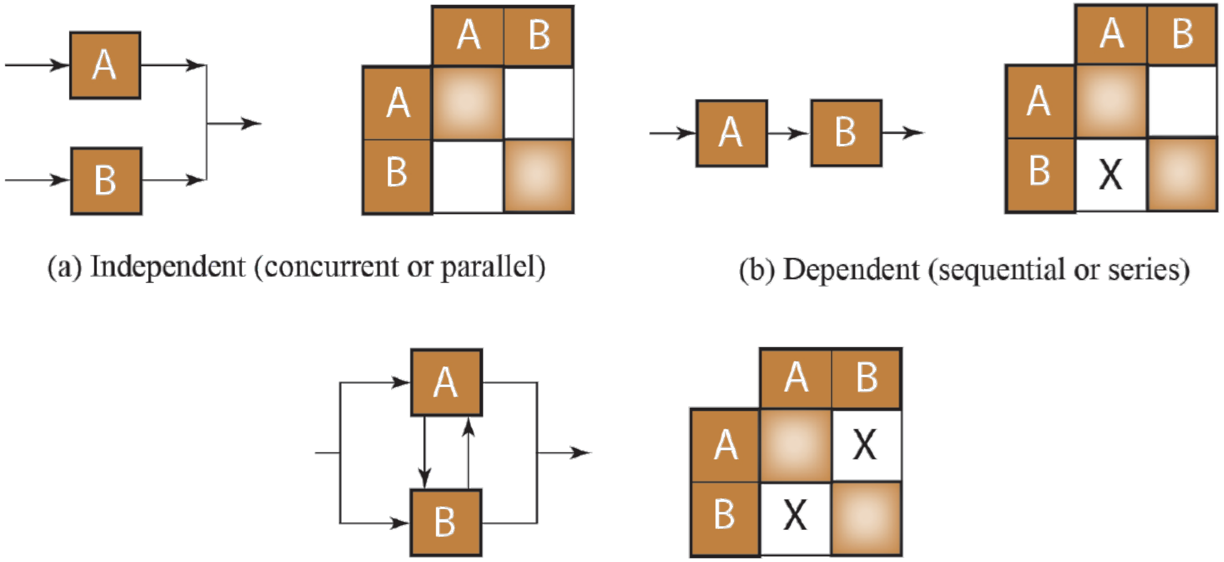
- **Task/activity-based DSM** analyzes relations among tasks or activities such as project scheduling and process modeling.

Parameter-Based DSM

- **Parameter-based DSM** analyzes relationships among a set of design parameters in complex system architecture. Building and analyzing a parameter-based DSM is similar to activity-based DSM.

Design Dependencies

Design Structure matrix shows design dependencies where the information flow between activities is visualized. The figure shows three general dependencies among elements in a system.



(a) Independent (concurrent or parallel)

(b) Dependent (sequential or series)

(c) Interdependent (coupled)

Figure 5.2: Dependencies among elements.

Matrix-Based Systems Modeling

The tasks are listed as close as possible to the order they should be completed.

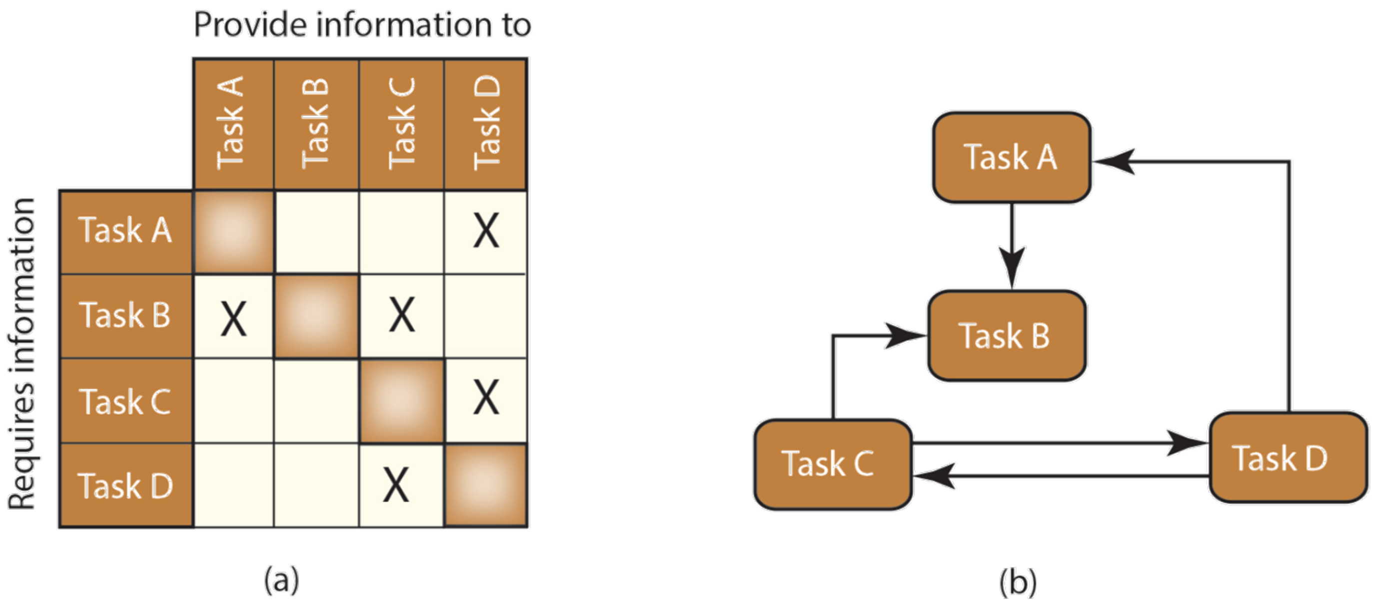


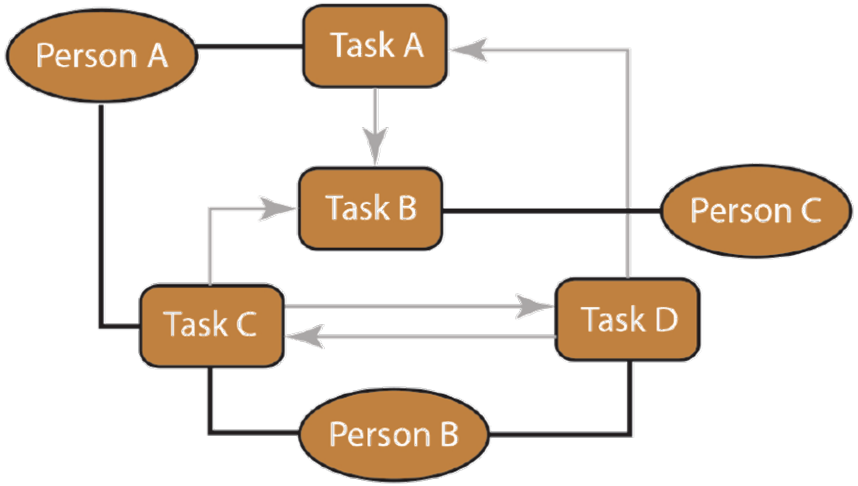
Figure 5.3: Dependencies among DSM elements.

Domain Mapping Matrix (DMM)

DMM represents relations between elements of different domains.

	Task A	Task B	Task C	Task D
Person A	X		X	
Person B			X	X
Person C		X		

(a)



(b)

Figure 5.4: Domain mapping matrix.

Domain Mapping Matrix (DMM): Example

Responsible (R)**:** Person who does the work to complete the task.

Accountable **(*Approver*) (A): P**erson finally accountable for the correct and thorough completion of the task (signs and approves the work that responsible provides)

	Scheduling/ Planning	Risk Analysis	Production	Testing	Budget	...	...	...
John	A	R	A	A				
Mark	R				A			
Jesse			R					A
Person					R			
Person							R	
. . .						A		

Figure 5.5: Distributing responsibilities through domain mapping matrix.

Multiple Domain Matrix

MDM combines DSM and DMM to show the interactions among different types of dependencies and domains.

MDM includes DSMs along its diagonal and DMMs outside the diagonal as shown in Figure 5.6.

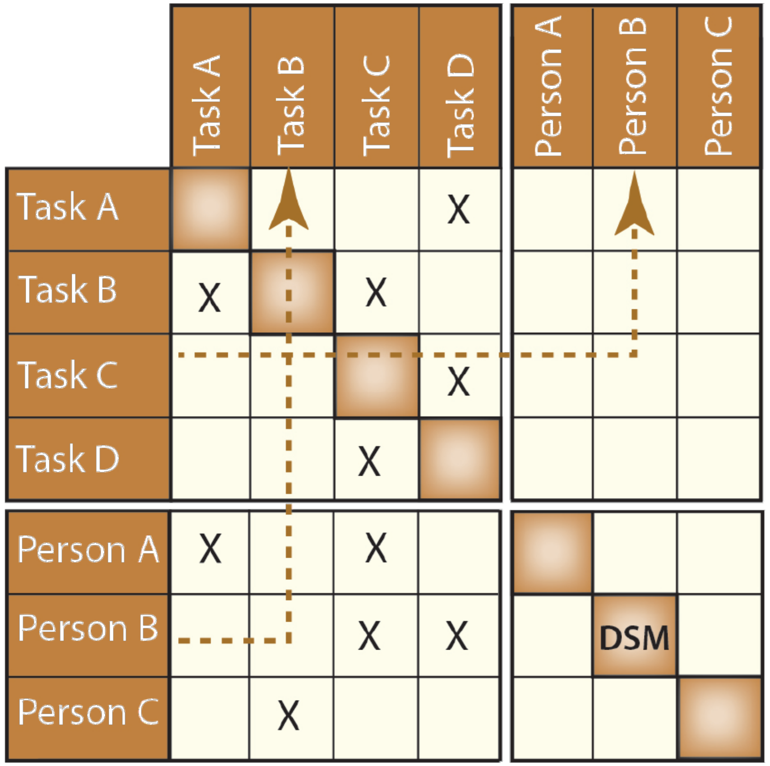


Figure 5.6: Multiple domain matrix.

Design Structure Matrix Partitioning

The process of the partitioning of a DSM is performed by reordering DSM rows and columns so that the new DSM turns out to be a block-diagonal matrix (i.e., lower triangular matrix).

Above the diagonal of DSM (upper triangular matrix), marks of feedback or cycles are not desirable – requires time-consuming iterations.

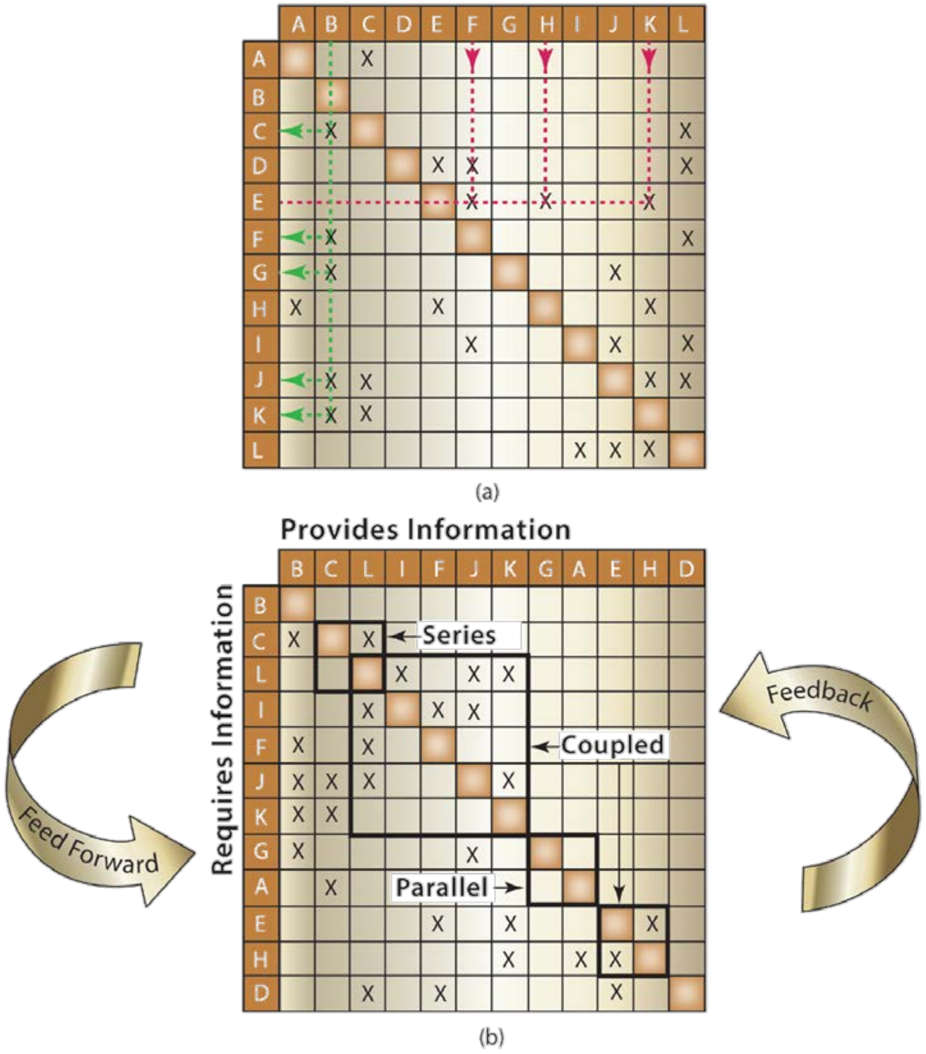
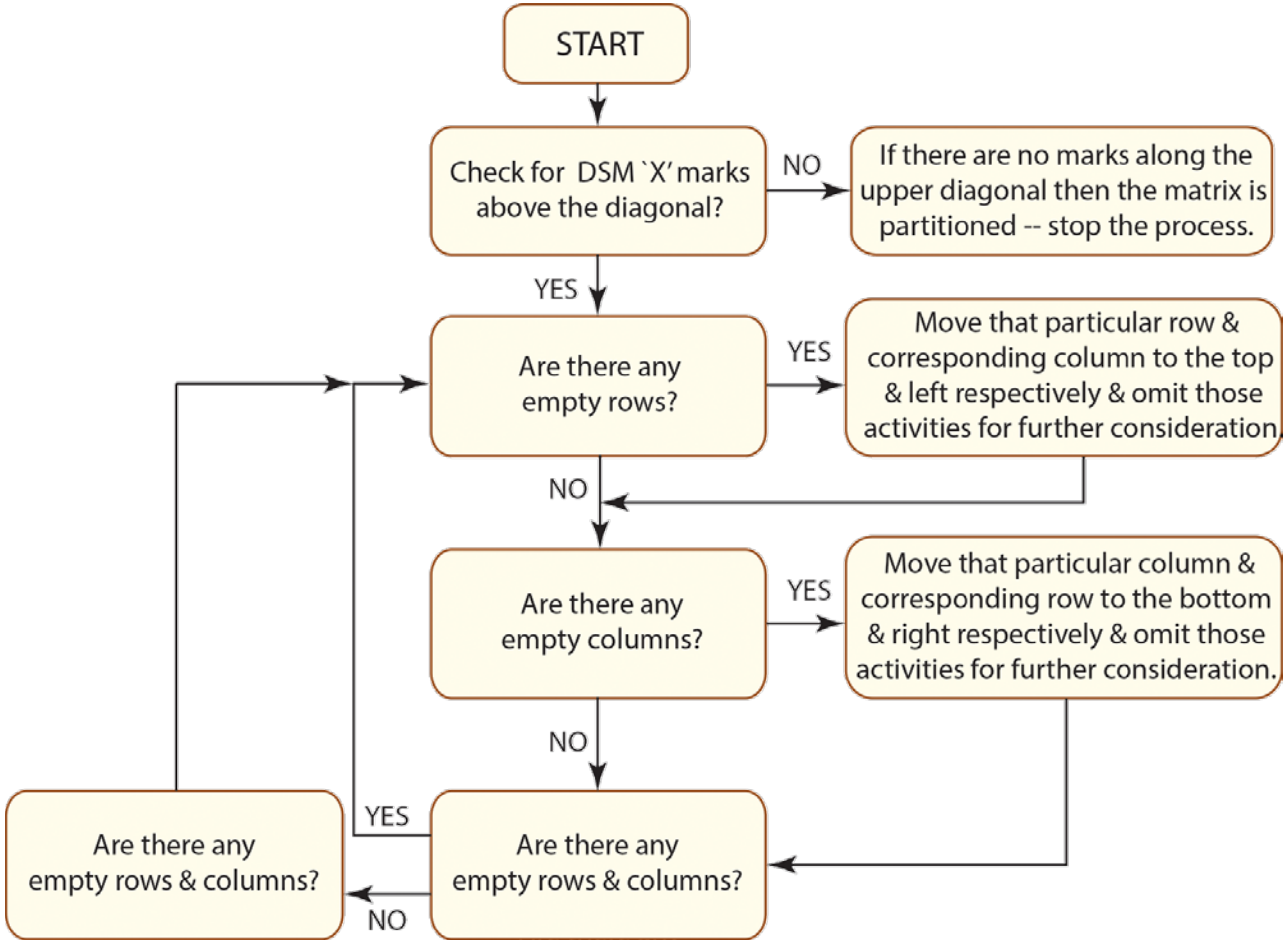


Figure 5.7: (a) Base DSM; (b) Partitioned DSM. (Adapted from: Yassine, A., and Braha, D., 2003.)

Process of Partitioning



Example 1: Partitioning

Figure 5.10 shows the relationships of four tasks. Using topological sorting and path searching method partition DSM matrix shown in Figure 5.10.

	Task A	Task B	Task C	Task D
Task A			X	
Task B			X	X
Task C	X			X
Task D				

Figure 5.10: Unpartitioned DSM matrix.

Example 1: Partitioning

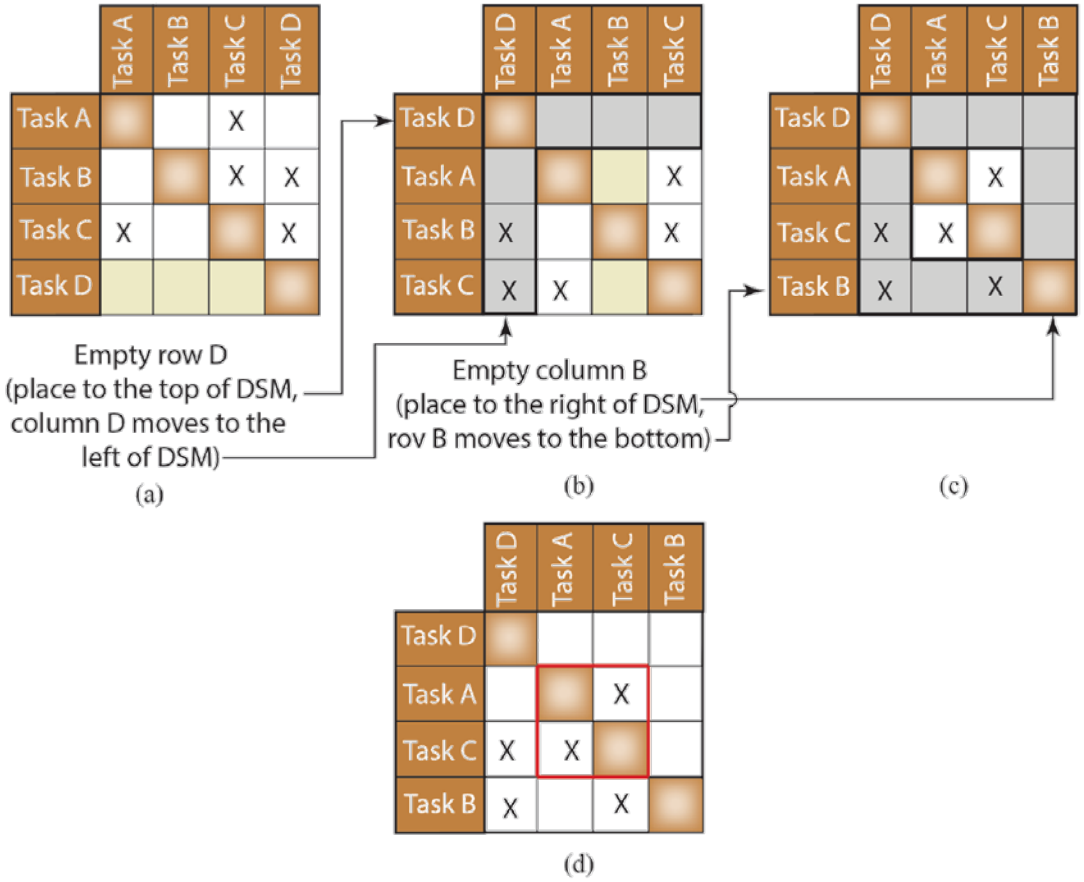


Figure 5.11: DSM partitioning.

Example 2

Assume that a team of seven students working on a design project. Use team-based DSM to show the information flow between the members within the sub- teams and the information flow (or interactions) among the sub-teams.

Team has following three sub-teams.
Team A = Members 1, 5, and 6
Team B = Members 4 and 5
Team C= Members 2, 3, 4, and 7

	1	2	3	4	5	6	7
1					X	X	
2			X	X			X
3		X		X			X
4		X	X		X		X
5	X			X		X	
6	X				X		
7		X	X	X			

Figure 5.14: Rocket competition sub-team.

Example 2 (a)

The first step replace rows 2 and 3 with rows 5 and 6 as shown in Figure 5.15(b). This manipulation is logical because we would like to bring members of Team A together.

The second step is to bring coupled entities 4 and 5 close to diagonal (see Figure 5.15(9b)). To accomplish this, swap the places of row 5 and row 6 (see Figure 5.15(c)).

The last step is to include remaining team members 2, 3, and 7 belong to Team C. As seen from Figure 5.15(d), three teams are clustered along the diagonal of the DSM to highlight the inter-team interfaces.

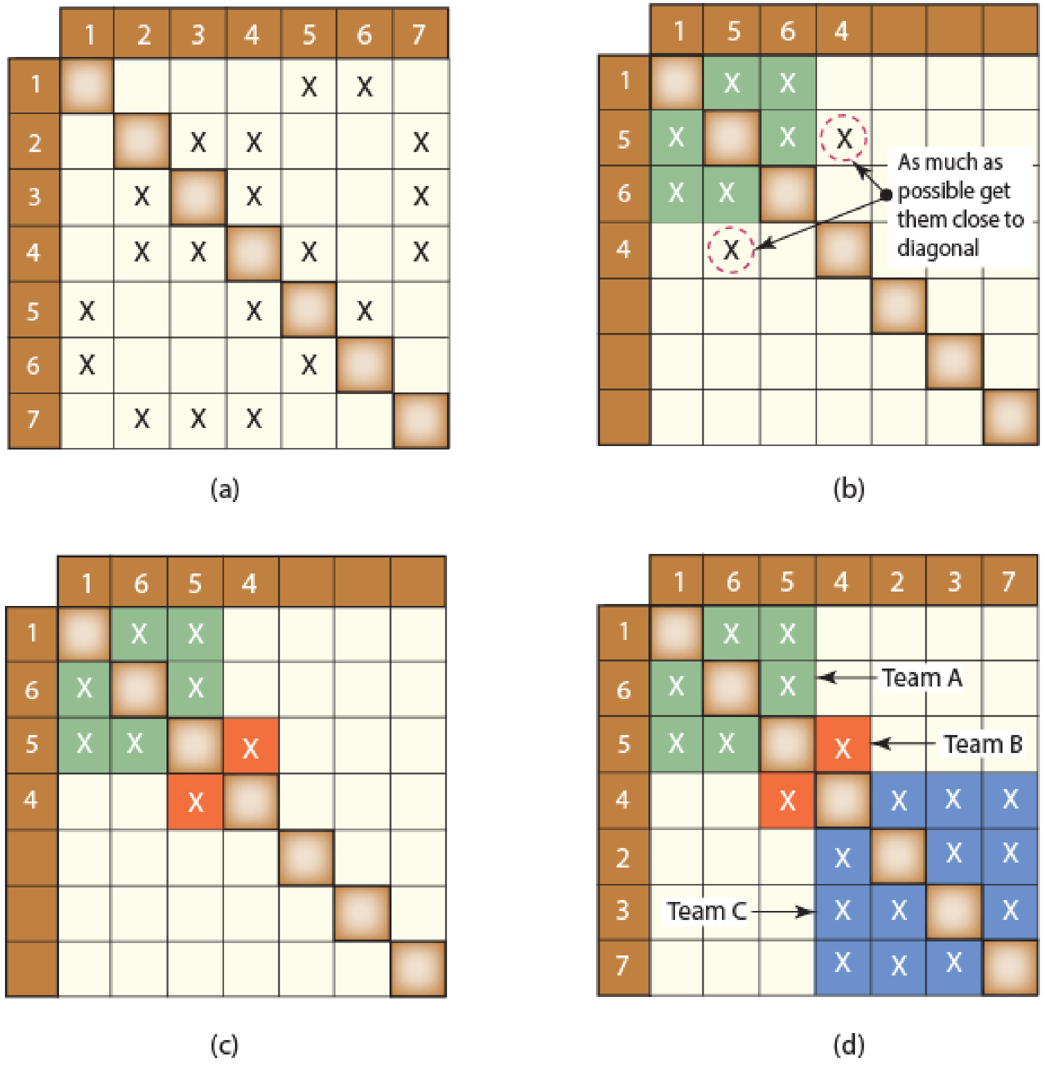


Figure 5.15: Sub-team partitioning.

Example 2 (b)

Frequency of Team Interactions

Figure 5.16 shows the frequency of interactions (daily, weekly, and monthly) within the teams and among the teams.

Team members or teams working on different parts of a system or product must integrate their designs by frequent information exchange and communication with those of the other team members to make sure that the entire system or product will function properly as a whole.

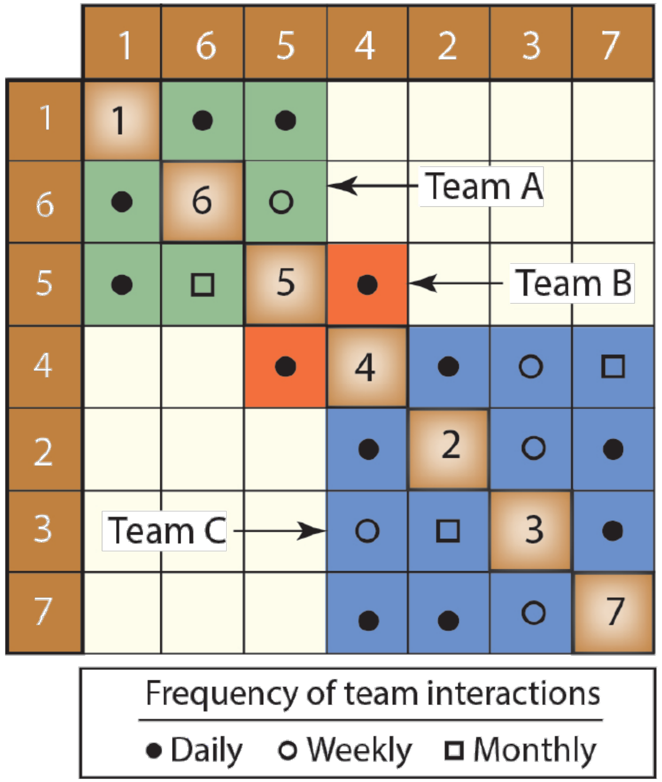


Figure 5.16: Frequency of team interactions.

Example 2 (b)

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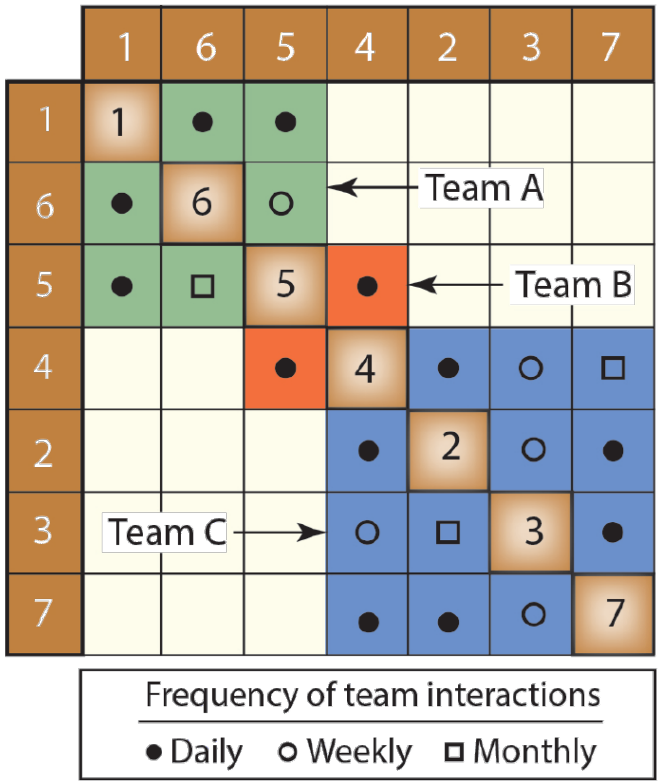

Figure 5.16: Frequency of team interactions.

“This is a story of four people named Everybody, Somebody, Anybody, and Nobody. There was an important job to be done and Everybody was asked to do it. Everybody was sure Somebody would do it. Anybody could have done it, but Nobody did it. Somebody got angry about that because it was Everybody’s job. Everybody thought Anybody could do it, but Nobody realized that Everybody wouldn’t do it. It ended that Everybody blamed Somebody when Nobody did what Anybody could have done.”

Charles R. Swindoll

Complex System Design

As seen from Figure 5.18, the 2-stroke marine engine power system has three sub-systems:

- fuel supply sub-system
- steam supply sub-system, and
- fuel oil injection sub-system.

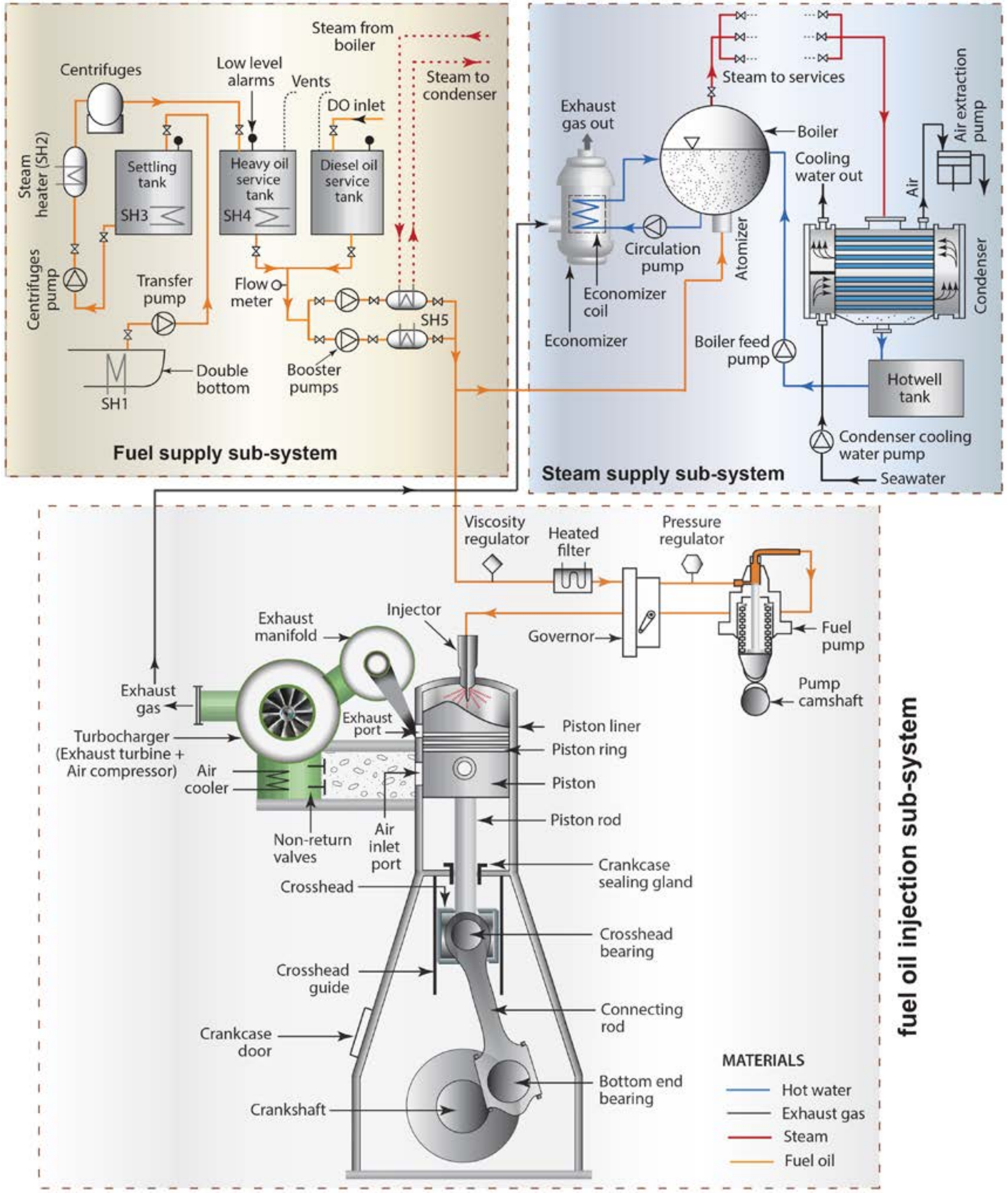

Figure 5.18: Two cycle marine diesel engine power system.

Complex System Design

Figure 5.19 shows a simplified version of two sub-systems:

- fuel supply sub-system and
- steam supply sub-system.

There are interactions and relationships within the sub-systems and among the subsystems are.

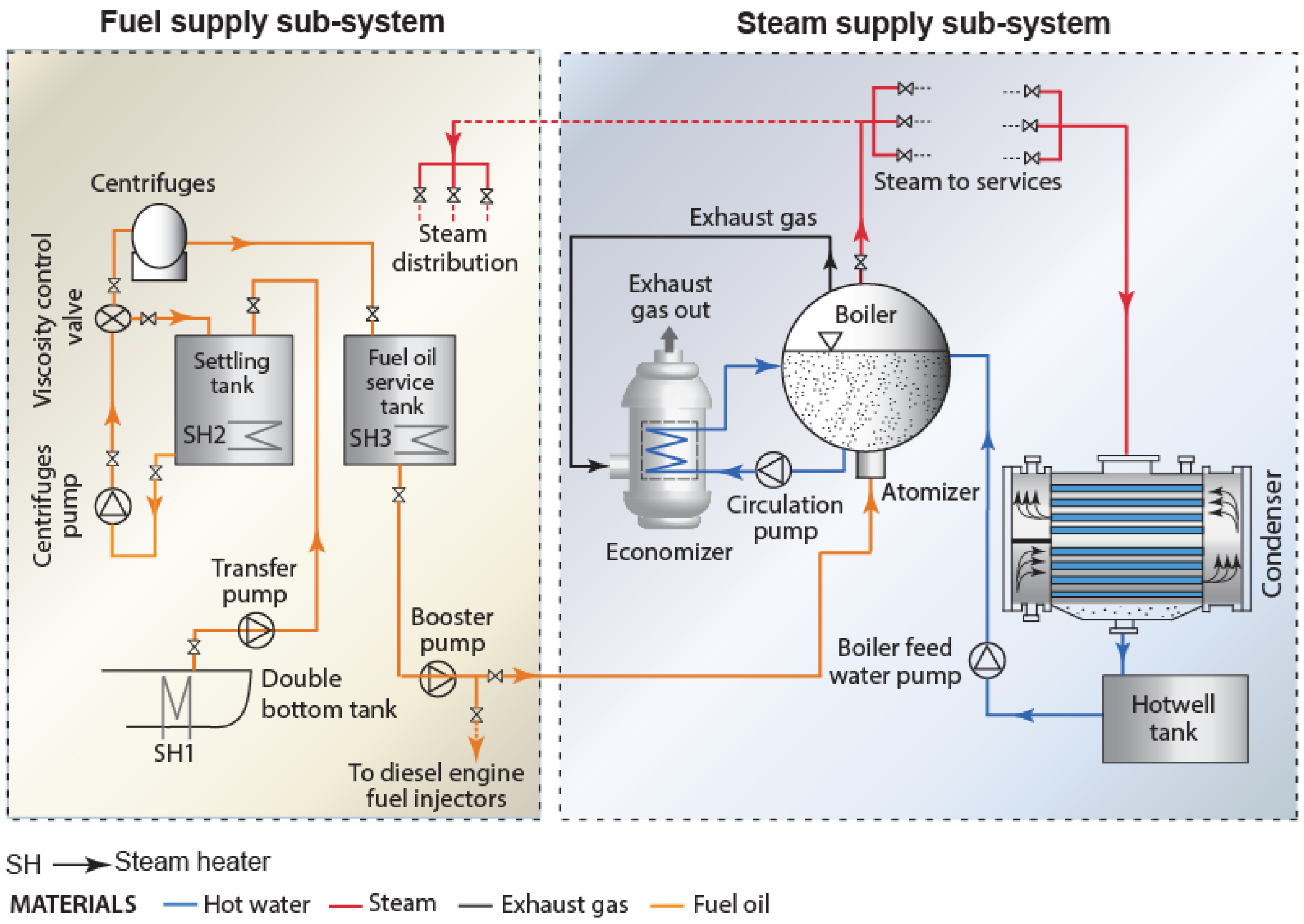

Figure 5.19: Fuel/Oil and boiler sub-systems.

EXAMPLE

Select the proper system components to design and build the sub-systems given in Figure 5.19 and investigate the interactions within and among the sub-systems. Complete the system analysis following Figure 5.20.

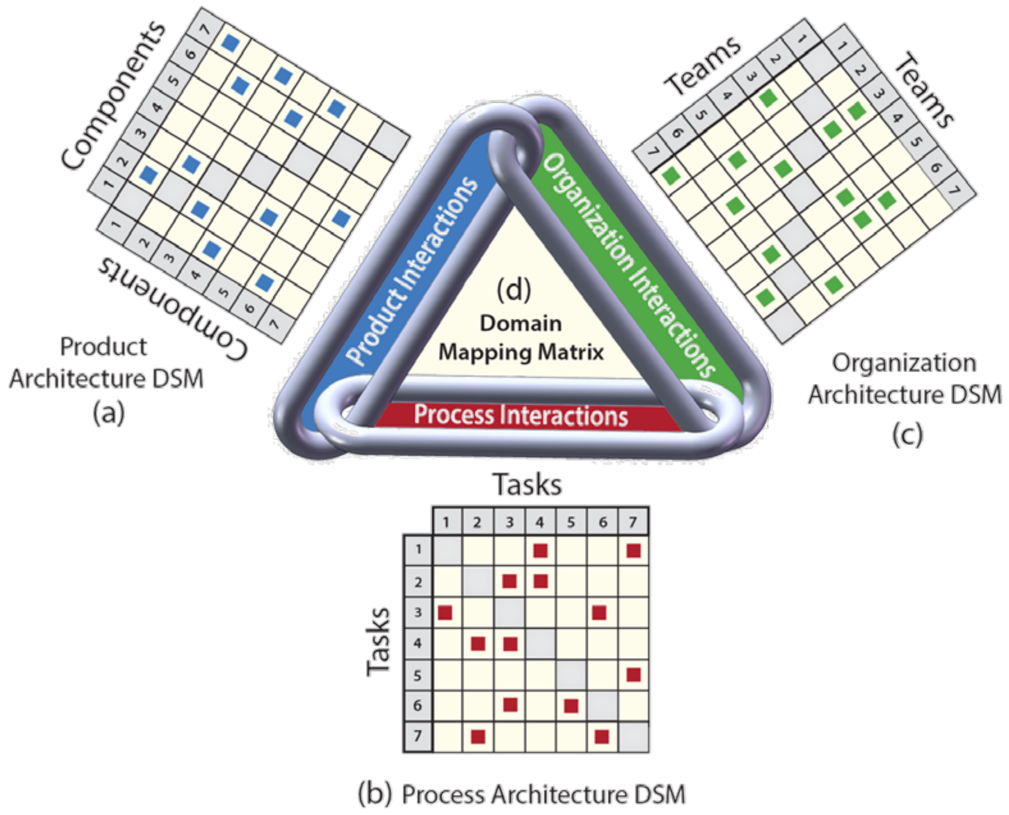

Figure 5.20: Creating DMMs from three basic DSMs.(Ref. a, b)

(a) **Product (or system) Architecture DSM**

Using Figure 5.19, sixteen components that affect the functionality of the subsystems are identified for the analysis. Interactions between the components are designated by “numbers” in the DSM matrix as shown Figure 5.21.

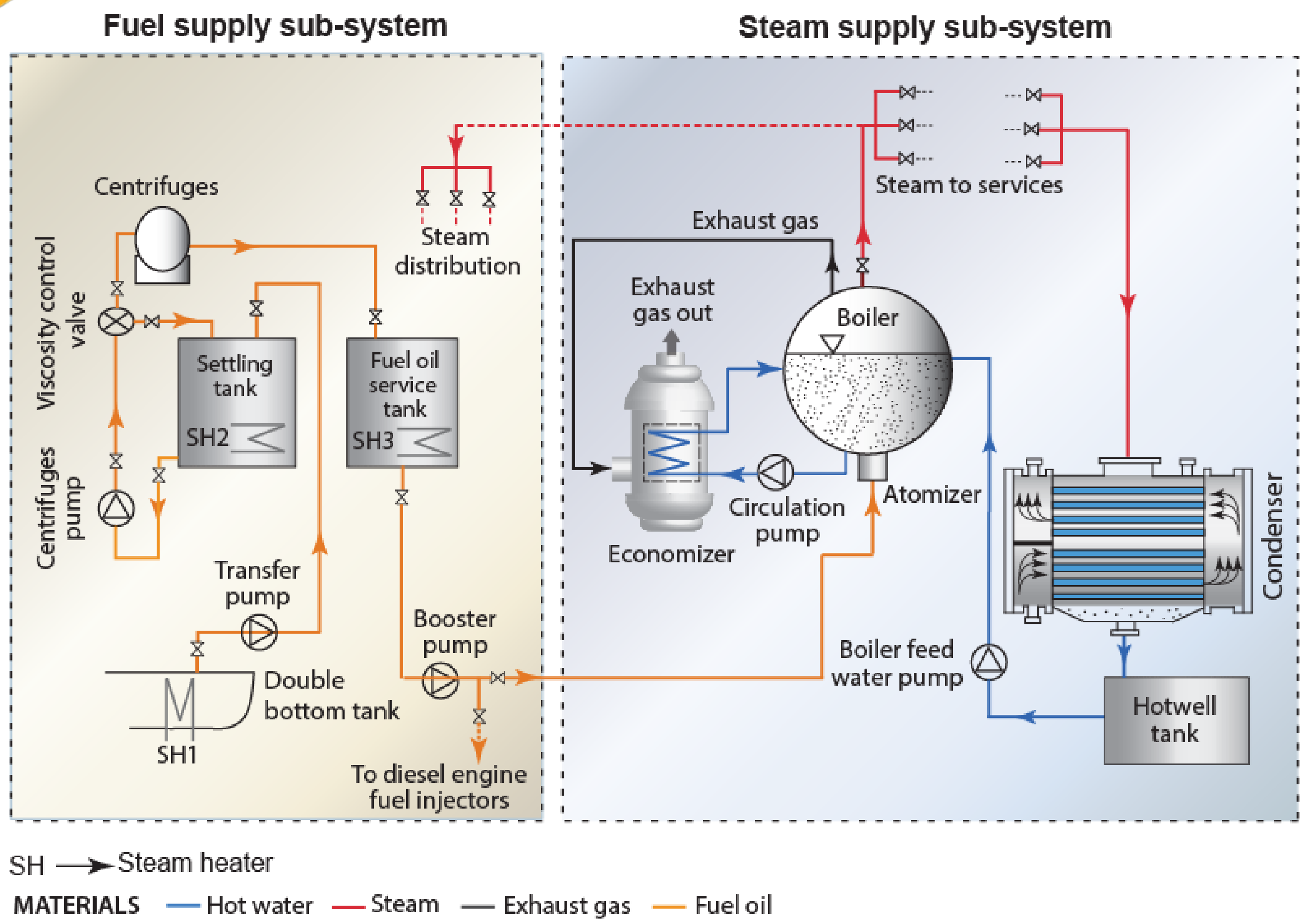

Figure 5.19: Fuel/Oil and boiler sub-systems.

Component Base DSM	COMPONENTS	Double bottom	Settling tank	Fuel oil service tank	Transfer pump	Centrifuges pump	Viscosity control valve	Booster pump	Centrifuges	Steam heaters (SH1-3)	Atomizer	Boiler	Economizer	Circulation pump	Main feed pump	Condenser	Hotwell tank
COMPONENTS		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Double bottom	A	A			2					2							
Settling tank	B		B		2	2				2							
Fuel oil service tank	C			C				2	2	2							
Transfer pump	D	2	2		D												
Centrifuges pump	E		2			E	2										
Viscosity control valve	F					2	F		2								
Booster pump	G			2				G			1						
Centrifuges	H			2			2		H								
Steam heaters (SH1-3)	I	2	2	2						I							
Atomizer	J							1			J	2					
Boiler	K									1	2	K	2		2		
Economizer	L											2	L	2			
Circulation pump	M											2	2	M			
Main feed pump	N											2			N		2
Condenser	O									1						O	2
Hotwell tank	P														2	2	P

2 (blue) Relationships by energy exchange between two elements

2 (green) Relationships by material exchange between two elements (physical adjacency)

1 (green) Relationships by material exchange between two elements (no physical adjacency)

Figure 5.21: Product architecture DSM (identifies component interactions).

Partitioned Matrix

Using Figure 5.21, a partitioned matrix for the system components was developed (see Figure 5.22. Different types of relationships between the components are defined in the legends of Figure 5.21 and Figure 5.22.

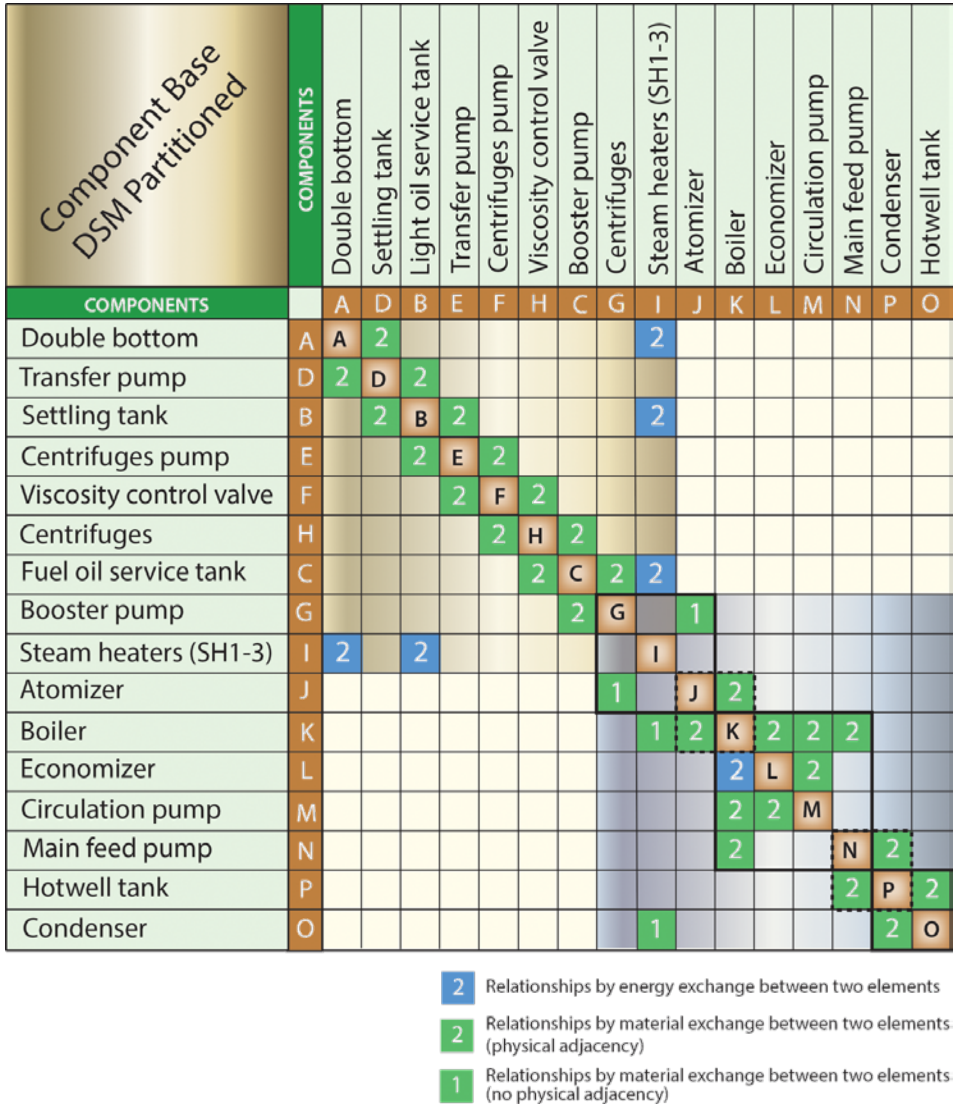

Figure 5.22: Sub-system components partitioned matrix.

(b) **Process Architecture DSM**

Using Figure 5.19, tasks descriptions and requirements are defined as follows.

TASK DESCRIPTIONS

Component selections: Selection of a preexisting manufactured component or the selection of a bespoke design (custom-made design) based on the fuel oil and water properties at that point in the system.

Steam Distribution: Determining the percentage of the boiler output that is going to be routed to specific tasks that rely on steam delivery (steam to services and steam distribution from the boiler).

Diesel Engine Requirement: Determining the fuel oil mixture properties that the diesel engine requires for optimum operation.

Viscosity Requirement: The monitoring of the fuel oil viscosity that each individual component needs for optimum performance and how the fuel oil viscosity changes as it travels through the system.

Overall System Efficiency: The determination of the ratio of system output (steam and exhaust) to system input (fuel oil and water) so that running costs can be estimated.

Overall System Flow Rate: The determination of the amount of fuel oil being consumed every hour so that the total time of operation per tank can be estimated. The determination of how much time passes from the commencement of boiler heating to max steam production occurring.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

1. Steam Distribution: None: The volume of steam needed by each service in the engine compartment and the steam heaters of the system is assumed to be known.

2. Diesel Engine Requirement: None: The fuel oil properties required for the engine to combust optimally are assumed to be known.

3. Boiler Selection

Steam Distribution: The volume of steam required by each steam dependent service dictates the output capability of the boiler.

Atomizer Selection: The heat generation capability of the atomizer will dictate the water volume of the boiler required so that an acceptable time interval passes from heat production to steam production.

4. Steam Heater Selection

Steam Distribution: The higher the volume of steam output from the boiler not being sent to the steam heaters will increase the time interval from steam leaving the boiler to the steam heaters reaching their operating temperatures.

Boiler Selection: The performance of the boiler will dictate what kind of steam heaters must be selected; a good boiler will require cheaper steam heaters while the poor boiler will require more expensive steam heaters to make up for the boiler's shortcomings.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

5. Atomizer Selection

Diesel Engine Requirement: The atomizer is fed fuel/oil in parallel with the diesel engine therefore the properties of the fuel/oil required by the diesel engine are going to dictate the combustion of the atomizer.

Boiler Selection: The size and shape of the boiler is going to dictate what kind of atomizer design will most efficiently heat the boiler through combustion.

6. Fuel Oil Pump Selections

Diesel Engine Requirement: The diesel engine will require the fuel oil at a certain pressure for optimum combustion and efficiency.

Centrifuge Selection: The centrifuges will need to be supplied with fuel oil at a certain pressure for optimum separation to occur in a timely manner.

Fuel Oil Tank Selection: The fuel oil must be pressurized enough to flow through the viscosity control valve, centrifuges, and still fill the light oil service tank at the same rate fuel/oil leaves the tank to supply the diesel engine and atomizer.

Settling Tank Selection: The transfer pump selection is dictated by the settling rate of the highly viscous fuel/oil pumped out of the double bottom and must keep the tank full.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

7. Centrifuge Selection

Fuel Oil Pump Selection: The centrifuges selected must be designed to operate at the incoming pressure and velocity of the fuel oil being pumped by the centrifuge pump for the optimum removal of impurities to occur.

Viscosity Requirement: The centrifuges must be selected to work with the viscosity of the fuel/oil at that point in the system because the viscosity of the fuel/oil will determine how fast they operate and how much wear they will experience.

8. Fuel Oil Tank Selection

Diesel Engine Requirements: The fuel oil requirements of the diesel engine with respect to viscosity and flow rate will dictate the size of the light oil tank to ensure that the fuel oil supply is constant. If the tank is too large the steam heater
will not be able to maintain the fuel oil temperature needed for the required viscosity.

Atomizer Selection: The fuel oil tank will need to supply fuel oil to the atomizer at a constant flow rate and must be taken into consideration when selecting the size of the tank.

Viscosity Requirement: The viscosity of fuel oil entering the light oil tank must be within the allowable range for the steam heater to lower the viscosity further during the time interval until it is pumped out to the diesel engine and atomizer.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

9. Settling Tank Selection

Diesel Engine Requirement: The settling tank must yield a high enough percentage of lowered viscosity fuel oil, from the double bottom, allowed through the viscosity control valve to continue to the diesel engine to meet the max requirement of the diesel engine. The volume of the tank and the flow rate must be large enough that the diesel engine receives its fuel oil requirement.

Fuel Oil Tank Selection: The fuel oil tank must maintain a level of fuel oil to allow for constant running for a specified number of hours and as such the settling tank must keep up with the discharge rate of the light oil tank.

Viscosity Requirement: The viscosity of the fuel oil being pumped to the viscosity control valve must be low enough that an allowable minimum must be forwarded to the centrifuges to keep up with the flow rate demands of the diesel engine and atomizer.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

10. Economizer Selection

Boiler Selection: The economizer is used to increase the efficiency of the boiler and decrease the time needed for max steam production to occur by utilizing the atomizer exhaust gas to preheat the water in the boiler. The size of the economizer shall be determined by the size of the boiler since the economizer is supplementary to the boiler.

Atomizer Selection: The choice of atomizer dictates the flow rate and quality of heat to transfer via the exhaust gases following the combustion process that the economizer will utilize.

11. Condenser Selection

Steam Distribution: The amount of steam that the condenser will receive from the boiler will dictate its flow rate, size, and type needed to preserve as much heat in the water after the phase change process to maintain high efficiency.

Boiler Selection: The steam output properties from the boiler will dictate what type of condenser will be required to phase change the water back into liquid without overcooling it.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

12. Hotwell Tank Selection

Boiler Selection: The volume of the boiler will dictate the size of the hotwell tank that is required. A smaller hotwell tank is desirable so less cooling will occur following condensation and more heat will be retained in the water as it is pumped back to the boiler.

Condenser Selection: The condenser limits the flow rate into the hotwell tank.

13. Feed Water Pump Selections

Boiler Selection: The circulation pump and main feed water pump control the volume of water present in the boiler. To regulate the temperature of the water in the boiler these two pumps need to work together to maintain a constant volume while steam leaves the boiler. The flow rate of steam leaving the boiler must be matched by the pumps feeding water to the boiler.

Economizer Selection: The economizer will require a certain flow rate of water from the circulation pump to raise the temperature of the water with the available heat from the exhaust gases.

Hotwell Tank Selection: The heat of the water pumped by the main feedwater pump from the hotwell tank may cause damage to pumps not designed to handle it and that must be considered.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

14. Viscosity Requirement:

The viscosity of the fuel oil being pumped to the viscosity control valve must be low enough that an allowable minimum must be forwarded to the centrifuges to keep up with the flow rate demands of the diesel engine and atomizer.

15. Overall System Efficiency

Steam Distribution, Diesel Engine Requirement, Steam Heater Selections, Atomizer Selection, Economizer Selection, and Condenser Selection:

To estimate the efficiency of the complete system, the amount of fuel oil harvested from the double bottom minus the amount used by the diesel engine through the atomizer must be known. The exhaust gas volume and temperature from the combustion process used by the economizer and boiler must be known. The boiler and economizer water volume must be known as well as the heat transfer from the atomizer exhaust into those two volumes. The amount of steam produced by the boiler and sent to the steam heaters and the condenser must be known.

TASK INTERACTION DESCRIPTIONS (INFORMATION REQUIREMENTS)

16. Overall System Flow Rate

Steam Distribution, Diesel Engine Requirement, Boiler Selection, Steam Heater Selections, Atomizer Selection, Fuel Oil Pump Selections, Centrifuge Selection, Viscosity Requirement, Economizer Selection, Condenser Selection, and Feed Water Pump Selections:

To estimate the flow rate of fuel oil the selections of all fuel oil components must be known because the velocity, pressure, and viscosity of the fuel/oil will vary as it moves away from the double bottom. The flow rate at each component will enable the flow rate of the fuel oil from the double bottom to the atomizer to be calculated. The water flow rate will be determined in a similar manner using the water components so that the flow rate of water from the boiler to the steam heaters will be calculated.

(b) **Process Architecture DSM**

To develop the interaction matrix shown in Figure 5.23 define tasks descriptions and requirements (see Chapter 5).

Task Interaction DSM — TASKS		1 Overall System Efficiency	2 Overall System Flow Rate:	3 Boiler Selection	4 Condenser Selection	5 Economizer Selection	6 Steam Distribution	7 Hotwell Tank Selection	8 Steam Heater Selection	9 Diesel Engine Requirement	10 Atomizer Selection	11 Centrifuge Selection	12 Settling Tank Selection	13 Fuel Oil Tank Selection	14 Fuel/Oil Pump Selections	15 Water Pump Selections	16 Viscosity Requirement
Overall System Efficiency	1	1			X	X	X		X	X	X						
Overall System Flow Rate	2		2	X	X	X	X		X	X	X	X			X	X	X
Boiler Selection	3			3			X				X						
Condenser Selection	4			X	4		X										
Economizer Selection	5			X		5					X						
Steam Distribution	6						6										
Hotwell Tank Selection	7			X	X			7									
Steam Heater Selection	8			X			X		8								
Diesel Engine Requirement	9									9							
Atomizer Selection	10			X						X	10						
Centrifuge Selection	11											11			X		X
Settling Tank Selection	12									X			12	X			X
Fuel Oil Tank Selection	13									X	X			13			X
Fuel/Oil Pump Selections	14									X		X	X	X	14		
Water Pump Selections	15			X		X		X								15	
Viscosity Requirement	16									X	X	X	X	X	X		16

Figure 5.23: Process architecture DSM (identifies tasks interactions).

Partitioned form of Figure 5.23 is shown in Figure 5.24

Tasks 3 and 10 are interdependent or coupled therefore constant communication must occur between these two tasks. Multiple iterations may be required to complete both tasks after an initial assumption about one of them is made. The cluster loop of coupled tasks 14, 11, 13, 16, and 12 is the most complex and tedious part of the project. The highest number of iterations is going to occur with this cluster because of its size.

Task Base DSM Partitioned	TASKS	Steam Distribution	Diesel Engine Requirement	Boiler Selection	Atomizer Selection	Steam Heater Selection	Fuel Oil Pump Selections	Centrifuge Selection	Fuel Oil Tank Selection	Viscosity Requirement	Settling Tank Selection	Economizer Selection	Condenser Selection	Hotwell Tank Selection	Water Pump Selections	Overall System Efficiency	Overall System Flow Rate
TASKS		6	9	3	10	8	14	11	13	16	12	5	4	7	15	1	2
Steam Distribution	6	6															
Diesel Engine Requirement	9		9														
Boiler Selection	3	X		3	X												
Atomizer Selection	10		X	X	10												
Steam Heater Selection	8	X		X		8											
Fuel Oil Pump Selections	14		X				14	X	X		X						
Centrifuge Selection	11						X	11		X							
Fuel Oil Tank Selection	13		X		X				13	X							
Viscosity Requirement	16		X		X		X	X	X	16	X						
Settling Tank Selection	12		X						X	X	12						
Economizer Selection	5			X	X							5					
Condenser Selection	4	X		X									4				
Hotwell Tank Selection	7			X									X	7			
Water Pump Selections	15			X								X		X	15		
Overall System Efficiency	1	X	X		X	X						X	X			1	
Overall System Flow Rate	2	X	X	X	X	X	X	X		X		X	X		X		2

Figure 5.24: Partitioned tasks interaction matrix with loops clustered

Table 5.5: Suggested task completion sequence.

Executed	Task(s) #	Reasoning
1st	6 and 9	Do not require any input but affect twelve other tasks.
2nd	3	6 is completed. Iterate assuming that 8 will be the most efficient option and reiterate if the boiler meets the steam requirements.
3rd	10	9 is completed and the iteration result for 3 will be checked.
4th	8, 5, and 4	6, 3, and 10 have been completed.
5th	7	3 and 4 have been completed.
6th	15 and 1	6, 9, 3, 10, 8, 5, 4, and 7 have been completed.
7th	13	9 and 10 have been completed. Iterate assuming the steam heater will be capable of providing the correct exit viscosity to the fuel oil inside the light oil tank.
8th	14a and 12	14a being the selection of the booster pump since all components interacting with it have been selected. The choice of settling tank must reflect the size of the light oil tank which is known. Iterate assuming the steam heater will be capable of providing the correct exit viscosity to the fuel/oil inside the settling tank.
9th	14b and 11	14b being the selection of the centrifuges pump since that will influence the centrifuge type selected. Choose the cheapest type of centrifuge and assume that the inlet viscosity will be acceptable.
10th	14c and 16	14c being the selection of the transfer pump since it is the only pump left. Calculate the fuel oil viscosity at the inlet and outlet of all components to see if assumptions are acceptable or if another iteration is required.
Last	2	Requires the most inputs but is not required by other tasks.

Task Base DSM Partitioned

TASKS	TASKS	Steam Distribution 6	Diesel Engine Requirement 9	Boiler Selection 3	Atomizer Selection 10	Steam Heater Selection 8	Fuel Oil Pump Selections 14	Centrifuge Selection 11	Fuel Oil Tank Selection 13	Viscosity Requirement 16	Settling Tank Selection 12	Economizer Selection 5	Condenser Selection 4	Hotwell Tank Selection 7	Water Pump Selections 15	Overall System Efficiency 1	Overall System Flow Rate 2
Steam Distribution	6	6															
Diesel Engine Requirement	9		9														
Boiler Selection	3	X		3	X												
Atomizer Selection	10		X	X	10												
Steam Heater Selection	8	X		X		8											
Fuel Oil Pump Selections	14		X				14	X	X		X						
Centrifuge Selection	11						X	11		X							
Fuel Oil Tank Selection	13		X		X				13	X							
Viscosity Requirement	16		X		X		X	X	X	16	X						
Settling Tank Selection	12		X						X	X	12						
Economizer Selection	5			X	X							5					
Condenser Selection	4	X		X									4				
Hotwell Tank Selection	7			X									X	7			
Water Pump Selections	15			X								X		X	15		
Overall System Efficiency	1	X	X		X	X						X	X			1	
Overall System Flow Rate	2	X	X	X	X	X	X	X		X		X	X		X		2

(c) **Organization Architecture DSM**

Once the task interactions and sequencing has been completed the research team(s) will be created to take responsibility of the tasks to be executed.

The interactions between components and tasks are used to construct the team matrix.

Fuel oil (orange) and water (blue) component interactions can form two meta-teams quite easily.

The nature of the interaction of the teams will be divided into daily, weekly, and once. The interaction between the teams will be information exchange about the project tasks.

Team Base DSM	TASKS	Steam Distribution	Boiler Selection	Steam Heater Selection	Condenser Selection	Water Pump Selections	Economizer Selection	Hotwell Tank Selection	Diesel Engine Requirement	Atomizer Selection	Fuel Oil Tank Selection	Fuel Oil Pump Selections	Viscosity Requirement	Centrifuge Selection	Settling Tank Selection	Overall System Efficiency	Overall System Flow Rate
TASKS		6	3	8	4	15	5	7	9	10	13	14	16	11	12	1	2
Steam Distribution	6	6															
Boiler Selection	3	O	3							W							
Steam Heater Selection	8	O	D	8													
Condenser Selection	4	O	D		4												
Water Pump Selections	15		D			15	D	D									
Economizer Selection	5		D				5			W							
Hotwell Tank Selection	7		W		D			7									
Diesel Engine Requirement	9								9								
Atomizer Selection	10		W						O	10							
Fuel Oil Tank Selection	13								O	D	13		W				
Fuel Oil Pump Selections	14								O		D	14		D	D		
Viscosity Requirement	16								O	W	W	W	16	W	W		
Centrifuge Selection	11											D	W	11			
Settling Tank Selection	12								O		W		W		12		
Overall System Efficiency	1	O		O	O		O		O	O						1	
Overall System Flow Rate	2	O	O	O	O	O	O		O	O		O	O	O			2

O → Once D → Daily W → Weekly

Figure 5.25: Organization (team) interactions matrix.