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DESIGN INTERFACE MANAGEMENT SYSTEM (DIMS) FOR CONSTRUCTION PROJECTS

V. Senthilkumar[1], Koshy Varghese[2]
[1]Research scholar, BTCM Division, IIT Madras India
[2]Professor, BTCM Division, IIT Madras India

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1 INTRODUCTION

The complex information intensive and dynamic nature of the fast track / concurrent construction design process makes it hard to manage the information flows using the traditional project management techniques and tools. Since the concurrent project execution advocates the Engineering Procurement and Construction (EPC) firm to start all its processes in parallel, design parameters involved in the process are dynamic in nature. The failure to anticipate the impact of the change of these design parameters generally affects the design quality, and causes design revisions, delay etc. Conventional design management procedures are partially successful in getting the designer's involvement because it is time intensive and designers are not sure if it will be useful. Moreover, the designers fail to anticipate all the probable design interfaces at the initial stage.

This paper proposes a new methodology 'DIMS' for managing dynamic design information in the detailed design phase. It has five main components, (i) Identification/Definition of project elements, (ii) Development of the Physical Interface Matrix (PIM): capturing the physical interfaces among the components, (iii) Development of Design Interface Matrix (DIM): capturing the design interfaces between the components and the disciplines, (iv) Development of Design Interface Agreement (DIA): capturing the detailed design interface parameters, (v) Developing Drawing DSM: capturing the design interfaces between the drawings and its Optimization to ensure optimal drawing release sequences. This methodology is demonstrated through implementation on an industrial design project.

2 DSM METHODOLOGY

The DSM methodology has been applied in various design domains including construction (Rogers and Salas, 1999; Eppinger et al., 1994; Tang et al., 2000, Austin et al. 1996). The utilization of DSM based tool in real world projects is constrained by its size and factors such as distributed work culture, expert time etc(Senthilkumar and Varghese, 2008) . Although extensive DSM research has been carried out in activity sequencing and iteration modelling for all levels of the design process, little work has been done in formulating the DSM and capturing the interfaces at various levels of the construction design process (Eppinger et al., 2008). The objective of this work is to: (i) Propose a structured methodology to decompose and integrate the project at appropriate levels to minimize the size of the DSM (ii) Evolve a methodology to capture the design interfaces with minimum effort from the designers and utilizing distributed work culture concepts and (iii) Generate drawing vs drawing interfaces and manage the interfaces for design optimization.

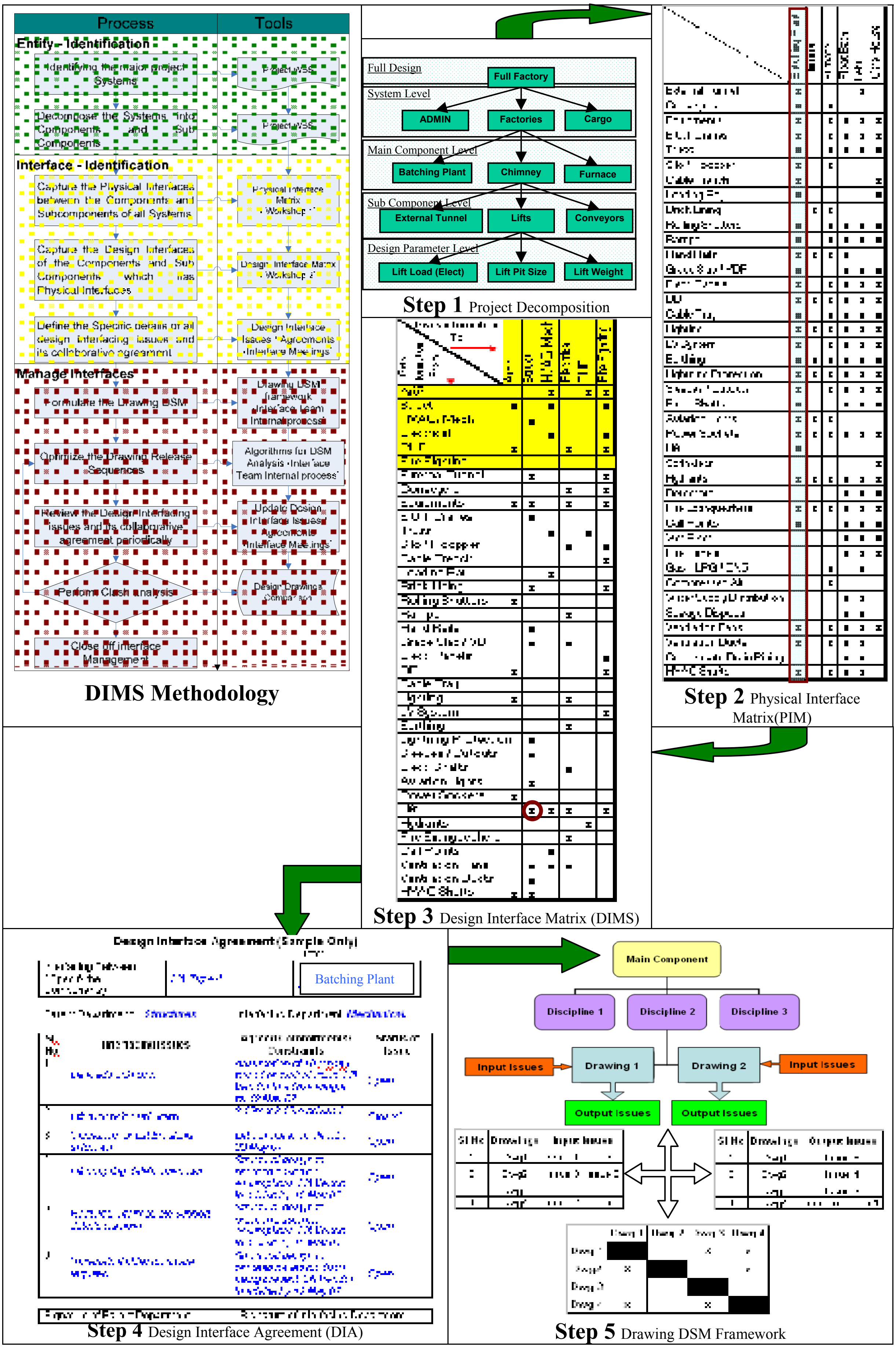
3 DIMS METHODOLOGY

Figure 1 shows the DIMS methodology and various steps involved in it, the methodology is shown in the left column.

In Entity-Identification stage, the project is decomposed into various levels as shown in Step 1 of figure 1. Various levels identified are systems, main components, subcomponents, disciplines and parameters.

In Interface-Identification stage, all parties involved are required to identify their interfaces with others parties through workshop or brainstorming session. In the detailed design stage, the design interfaces exist only when a component/ subcomponent has the physical interface with the other component /subcomponent. Hence the physical interfaces are captured for the top level elements in the hierarchy.

Figure 1 DIMS Model



The physical interfaces between the subcomponents/components are captured using the Physical Interface Matrix (PIM). Step 2 in figure 1 shows an example PIM of the Factory Region of a Glass Factory design.

From PIM, the components which have physical interfaces are grouped for capturing the design interfaces in the next step through Design Interface Matrix (DIM).

The DIM captures the design information interfaces between the physically interfaced components and the design disciplines involved. Step 3 in figure 1 shows an example DIM for a Batching Plant main component. The yellow region represents the general design interfaces between the disciplines apart from their subcomponent specific design interfaces. One cannot list out all the sub components which are present in main component. The missed out subcomponent's design interfaces can be captured through the first yellow region. The design interfaces are captured by populating the DIM through brainstorming, expert opinion or workshop. Then the same is updated in the subsequent meetings.

Next, each discipline enters the detailed interfacing issues in the form of Design Interface Agreement (DIA) as shown in step 4 of figure 1. In the illustration, the 'X' mark between 'Struct' and 'Lift' in the DIM is taken and the issues details related to the same are recorded in the DIA.

The final step is to identify the drawing and issues relationships through the framework presented in step 5 of figure 1. Based on this framework the drawing DSM is developed.

4 AUTOMATED TOOL 'diMs'

It is very difficult to implement the above methodology by the manual methods as it is tedious to maintain the documents and the matrices. Also the parties involved in the construction design process are distributed geographically which again makes the information flow complex and time consuming. A server based automated prototype tool using the above methodology called 'diMs' is developed to facilitate management of distributed concurrent design. The features of the tool will be further explained with the case study in the presentation.

5 SUMMARY

The DIMS methodology gives guidelines to the construction designer manager for decomposing and integrating the project design. The drawing DSM is developed through PIM DIM and DIA. These drawing dependencies are used for making decision in the drawing execution sequence. Also it is giving guidance to the designers to identify the affected parties because of the changes made in their drawings by the updated design information. The dynamic nature of this drawing DSM will also reduce the complexity in the interfaces as the design progresses.

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Contact: V. Senthilkumar
Indian Institute of Technology
BTCM Division, Civil Engineering Department,
600036, Chennai, Tamilnadu, India
Phone: +91 44 22575255. Fax: +91 44 22574252
vsenthil@iitm.ac.in

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V. Senthilkumar
Koshy Varghese

Indian Institute of Technology Madras, India

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Introduction

- Design - Driven by Information Exchanges
- Conventional Design – Sequential Execution
- Concurrent/ Fast Track Techniques – Parallel Execution
- Multidisciplinary Design – Interface Management
- Assumptions – Essential to Validate

Challenges of DSM Applications in Construction Projects

- Interface capturing process - Difficult - Size and structure of the project.
- Foreseeing all the interfaces at the start of the project – Difficult
- Tools - Not effective in assisting the interface identification process.
- More time required to develop the DSM – Designers involvement reduced
- Terminologies – Different - Not construction specific

FOLLOW THE FLOW OF INFORMATION!

MANAGE COMPLEX SYSTEMS

Objectives of diMs Methodology

(i) Propose a structured methodology to decompose and integrate the project at appropriate levels to minimize the size of the DSM

(i) Evolve a methodology to capture the design interfaces with minimum effort from the designers and utilizing distributed work culture concepts

(ii) Generate drawing vs. drawing interfaces and manage the interfaces for design optimization.

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FOLLOW THE FLOW OF INFORMATION!

MANAGE COMPLEX SYSTEMS

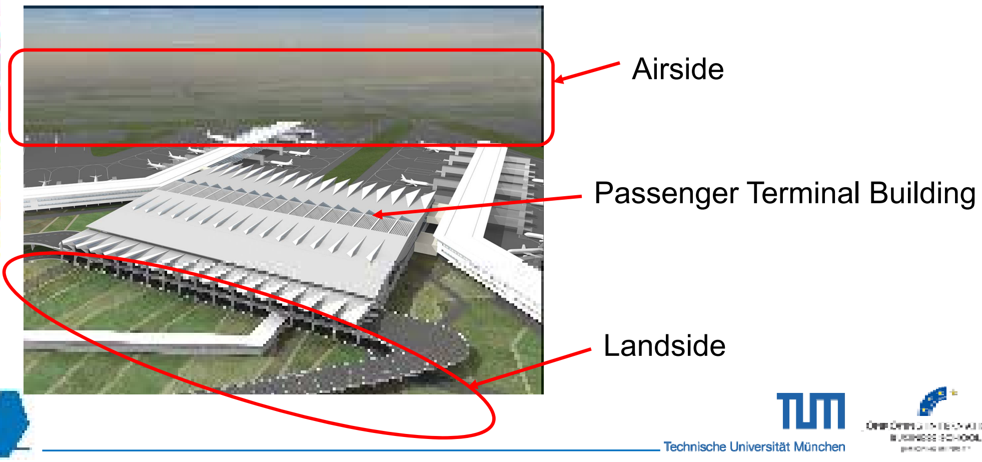
Terminologies

- **System** – Geographically distinct entity, created to meet specific high level functions. A project may consist of many systems.

  For example;

  – *Passenger Terminal Building, Airside and landside in Airport Project*

  – *Factories buildings, Admin buildings in Glass factory project.*



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Terminologies

- **Main Component** – Physical entity for which a specific category of drawings are produced. A system consists of many main components.

  For example;
  - *Each Floors in Passenger Terminal Building System in Airport Project*
  - *Batching Plant, Chimney, Furnace etc. in Factories building system on Glass Factories design*

Arrival Level

Departure Level

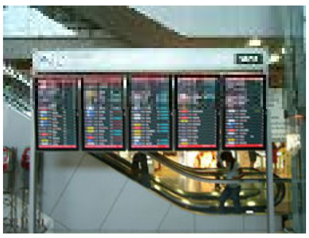
Restaurants and Shops Level

FOLLOW THE FLOW OF INFORMATION!
MANAGE COMPLEX SYSTEMS

Terminologies

- **Sub Component** – Also a physical entity which forms a part of the main component.

  For example;
  - *Lifts, Hand rails, HVAC Ducts, FIDS etc in PTB*
  - *Machineries, Ducts, Cranes and other lower level physical entities present in factories*



FIDS

Currency Exchange Kiosk

Lift

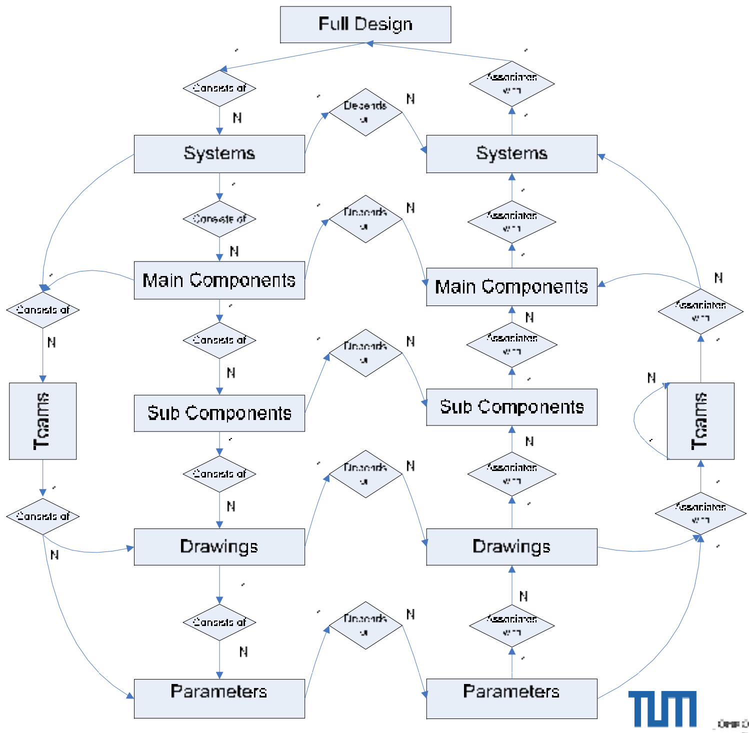
Terminologies

- **Team –** A Team is a group of people who are working for specific functional requirements of the project.
  For example:
  - Structural, Architecture, Electrical, HVAC, Client, Consultants, Vendors etc.

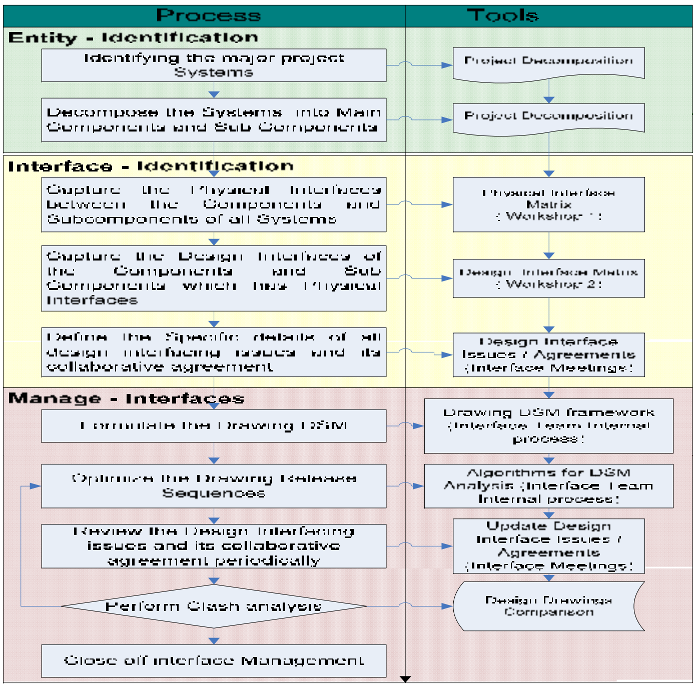
- **Drawing –** A drawing is a lowest physical output of the construction design, - based on the main components also Team specific.
  For example;
  - Basement foundation drawing by Structural engineering Team
  - Electrical cut-outs and wiring layout by Electrical engineering Team

- **Parameter -** A parameter is an input, output data in the design process. A drawing consists of many parameters.
  For example;
  - Depth of footing, cut-outs size
  - Sizes of reinforcements etc

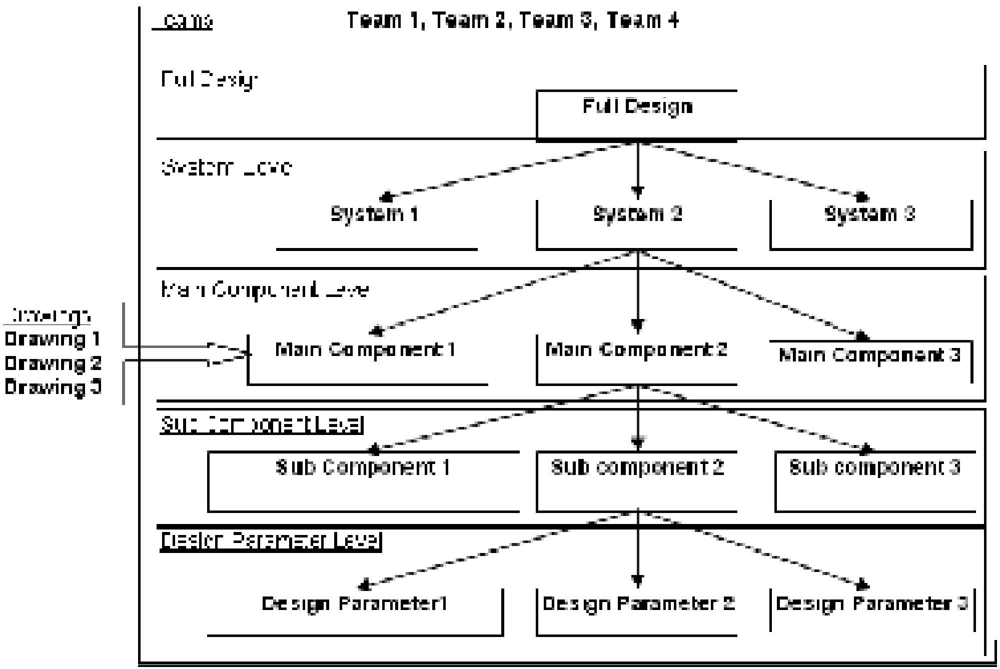
Relationship Diagram



diMs Methodology



Entities - Identification



Interface - Identification
Physical Interface Matrix (PIM)

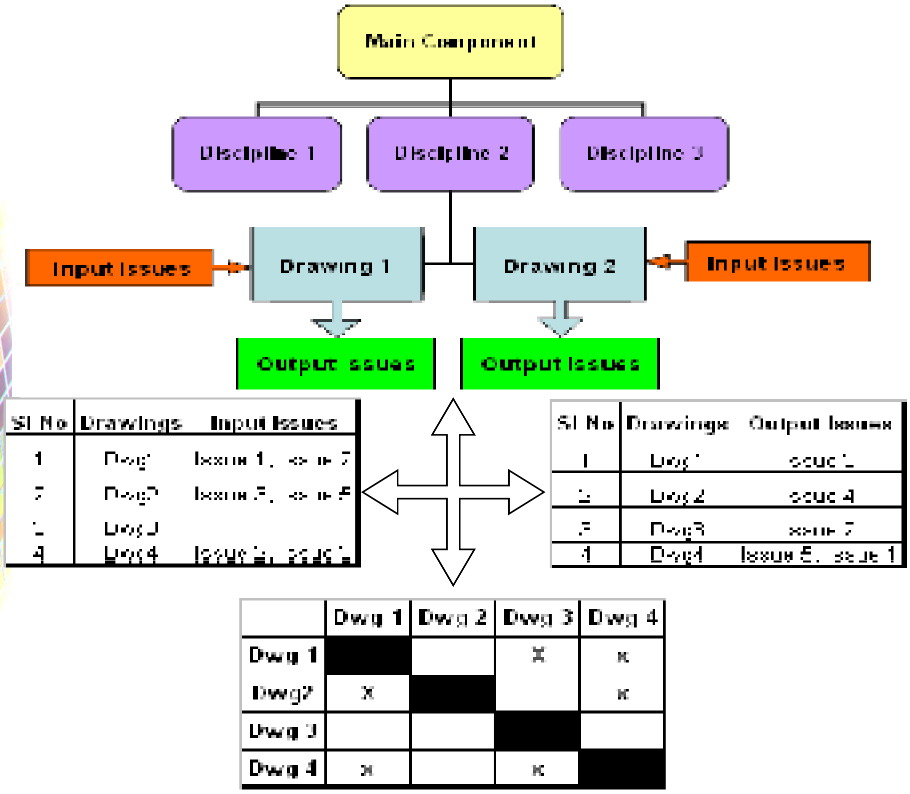
Sub Components ↓ / Main Component →	Main Component 1	Main Component 2	Main Component 3	Main Component 4
Sub Component 1	x		x	
Sub Component 2		x	x	
Sub Component 3	x		x	x
Sub Component 4	x	x		
Sub Component 5		x	x	x
Sub Component 6	x		x	
Sub Component 7	x			x

MANAGE COMPLEX SYSTEMS
FOLLOW THE FLOW OF INFORMATION!

Interface - Identification
Design Interface Matrix (DIM)

Gets Information from ↓ / Gives information to →	Team 1	Team 2	Team 3	Team 4
Team 1			x	
Team 2	x		x	
Team 3		x		
Team 4			x	
Sub Component 1		x		
Sub Component 3				x
Sub Component 4	x	x		x
Sub Component 6		x		
Sub Component 7			x	

Manage Interfaces – Drawing DSM Formation Framework



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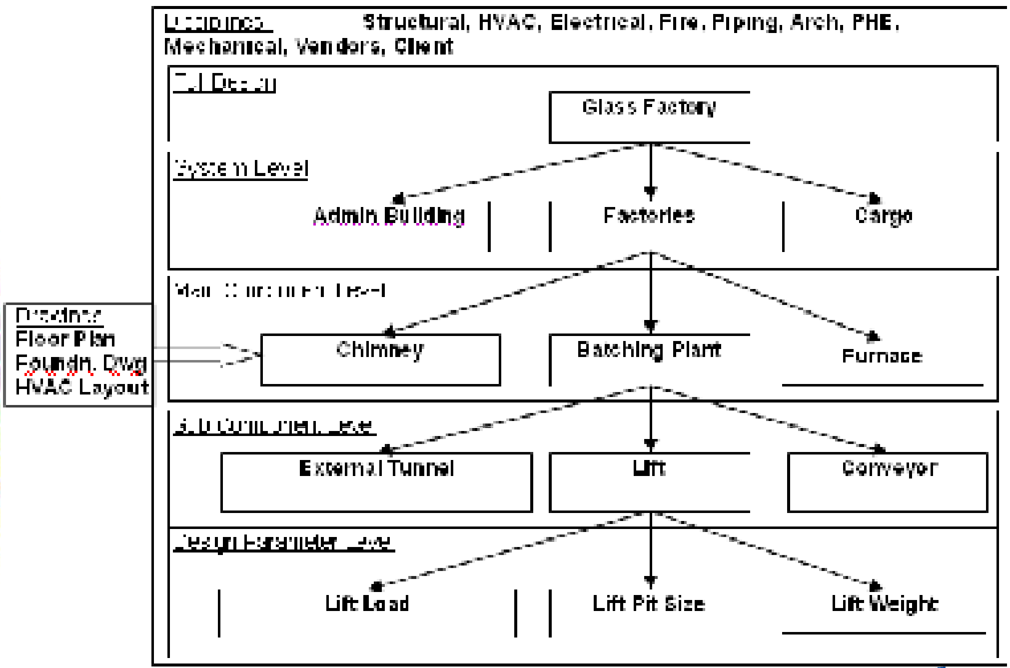
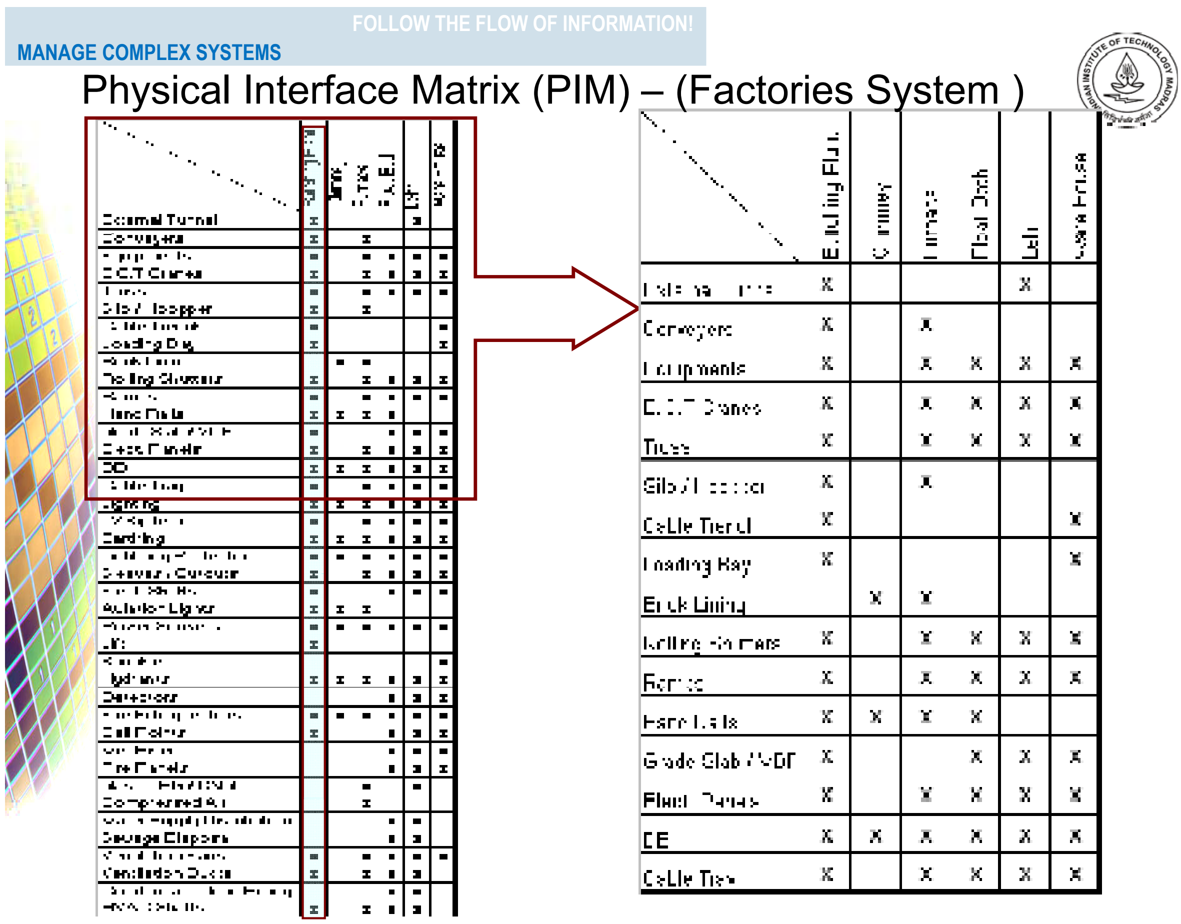
MANAGE COMPLEX SYSTEMS

Entities – Identification (Glass Factory Project)

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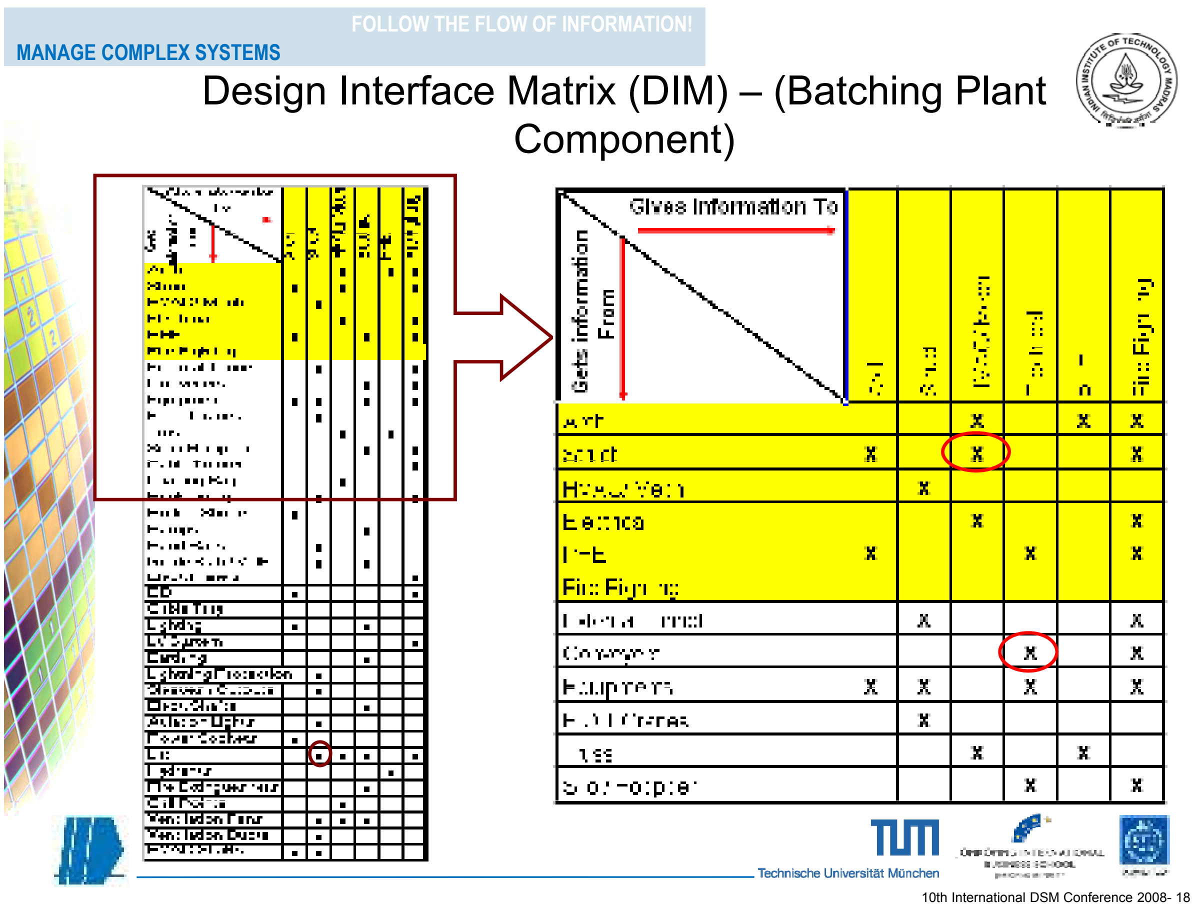
MANAGE COMPLEX SYSTEMS
Physical Interface Matrix (PIM) – (Factories System)
Conveyors
Equipments
Cable Trench
Loading Bay
Brick Lining
DE
Cable Tray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MANAGE COMPLEX SYSTEMS
Design Interface Matrix (DIM) – (Batching Plant Component)
Gives Information To
Gets information From
Electrical
Fire Fighting
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Design Interface Agreement (DIA)

Design Interface Agreement (Sample Only)

Date

Interfacing Between (Specify the Component(s))	[illegible]	Batching Plant

Parent Department: Structures   Interfacing Department: Mechanical

Sl. No	Interfacing Issues	Agreed Commitments/ Constraints	Status of Issue
[illegible]	[illegible]	[illegible]	Open
[illegible]	[illegible]	[illegible]	Closed
[illegible]	[illegible]	[illegible]	Open
[illegible]	[illegible]	[illegible]	Open
[illegible]	[illegible]	[illegible]	Open
[illegible]	[illegible]	[illegible]	Open

Signature of Parent Department	Signature of Interfacing Department

About “diMs”

- Server based Proto-type
- Developed using PHP and MySql
- Data are stored in DB tables
- Integrity and dynamic nature of the table is maintained by relating the DB tables

Summary

- Gives guidelines to the construction design manager for decomposing and integrating the project design.
- PIM, DIM captures the Physical and design Interfaces
- Drawing DSM is developed through PIM DIM and DIA.
- Drawing dependencies are used for making decision in the drawing execution sequence.
- Gives guidance to the designers to identify the affected parties because of the changes made in drawings by the updated design information.
- Dynamic drawing DSM reduces the complexity in the interfaces as the design progresses.
- Scope for utilizing the PIM for construction Interface needs to be further examined