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FMDI principle

Date: 10 July 2003 (original draft 26 June 1997)
Subject: Red-Bag FMDI principle
Reference: rb/bvis/001m

Purpose

The purpose of this paper is to document the FMDI principle that is one of the fundamental Red-Bag visions on automating technical management, engineering and design of process plants.

FMDI is the abbreviation of *Function, Material, Dimension and Interface* and was years ago developed by Red-Bag employees to be used as a guide to control the definition of process plant's components and accordingly report the progress during the design and engineering phase of a project.

This paper does not pretend to be complete or ready for any purpose, it is merely the recording of thoughts that mature in time.

Introduction

Since the 1980's the work for engineering and design has changed drastically due to the development of the personal computer. A striking example is the replacement of the drawing board by the electronic drawing device (PC or workstation), that had much more tools than just rulers and pencils. The Computer Aided Design (CAD) stations were one of the first visible changes to engineering and design work caused by computer usage on projects.

The development of computers and computer programs for engineering and design is continuing at a rapid pace. Because of that, the engineers and designers now also need to update their skills to include for the new way of engineering and to keep up with the developments in the future.

The computer usage is also well established in the project control discipline supporting the scheduling, progress and cost control of EPC projects. The fundamental control parameters for this discipline did not change as drastically as the engineering and design work did. For instance: it is still necessary to issue a drawing 'For Construction' to earn progress in the progress measurement system.

On many occasions the engineering and design is still controlled based on their output, being the drawings and other paper documents. The controlling of engineering and design on drawings is getting more and more out of line with the reality how these days the engineering and design work is executed.

For example: Control System Engineers are filling a database such as INtools with all the required information and the computer program generates most of the drawings. If a conventional progress measurement system is used, the result will be that during the first period the progress appears to be very low and only will pick up at the end of the design period when all the drawings are generated by the computer software. This will be in contrast with the more realistic situation of a fluent progress curve. The same applies for the piping design, the designer does not prepare the piping layouts and the isometrics but inputs data into a 3D CAD system such as PDS and PDMS. The computer programs generate the drawings and material lists.

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The computer will in the future support and facilitate the design work further. With the rapid growth of the internet it can be envisaged for the future that the designer connects the 3D CAD database to various suppliers of materials and equipment to enable direct use of actual dimensional data from suppliers rather than estimated dimensions at the start of the design work.

Based on the above experience the FMDI principle was developed as a method to determine and control only the minimum required data to define component according its intended purpose.

FMDI principle

This gradual change in executing engineering and design requires a new approach to controlling the project execution work. A new approach could be the so-called FMDI principle. FMDI stands for function, material, dimension and interface. This principle has been developed by Red-Bag to adapt the general project execution to the current development of design methods by means of computers and to have a seamless connection and data interface with the construction site. The construction execution phase of a project is not changed that much by computers and is not part of this FMDI approach.

Why FMDI?

The philosophy is born from the idea that each component in a process plant needs to be defined according the project requirements. If the definition is complete then the components can be ordered and the plant can be built. The main ingredients and essential data for the definition of a component according this principle are captured in the abbreviation of FMDI:

***F**unction*

The purpose of a process plant is to bring various process fluids together and to fabricate new products for the market. The purpose of the components in the plant is to make sure that the process works, the components enclose and activate the process fluids. A pipe is needed to transport the fluid at a certain pressure and a temperature. An elbow has an additional function, to change the direction of the stream. A pump has the purpose to make sure there is flow of fluids or to boost the pressure. An orifice plate is used to measure the flow by means of restricting the flow and creating a pressure drop. In most cases tagged components will have their function defined on a process datasheet. Bulk components will be defined in specifications such as the overall pipe specification. Also non-process wetted parts such as insulation, structural steel and cables will be defined in specifications or datasheets.

***M**aterial*

The plant components will be operating in a certain environment. This environment (including the process fluids) will define for a large part the type of component material. As example, the structural steel may need to withstand the sea (salty) environment or also the earthquakes, elbows in a piping system need to be of material suitable for the process but also for the outside environment. Without the proper definition of the material the component can not fulfil its intended function. This means that if the material is still on hold there is still a fundamental part of the component definition uncertain. Most of us will know from the execution of projects that a material change (or a functional change) of process components can have serious negative effects on the project progress.

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Dimension

The function and the material has been selected and defined. Now further detailing is possible. The component can be calculated to determine the required dimensions and sizes. The orifice plate is calculated based on the function, the function indicates the amount of flow and the allowable pressure drop. With the applicable formulas and additional requirements the dimensions and sizes are defined. The pipe needs to withstand the process pressure and temperature that will determine the wall thickness. The pump needs to deliver the required pressure that will determine the impeller, housing and the flange sizes. The function together with the selected material will be the basic ingredients that will be part of the calculation input to determine the sizes of the component. Again, without the proper function definition or the selected material, the dimensions of the component remain on hold and can be subject to change.

Interface

With the function, material and dimension definition the component appears to be completely defined. But an important aspect needs to be included in the definition of the component otherwise all the components are nice in a box but will not connect. The connections or interface is a similar important characteristic of the definition of a component. The component needs to fit and connect to the neighbor component otherwise the process plant can not be built or fulfil its function. An elbow needs to be tapered if it will connect to a pipe schedule with a smaller wall thickness. The pump needs to have the same type of flange as the pipe line to connect to the pipe system. The electrical voltage needs to correspond with the required voltage for a compressor. The interface aspect in the FMDI principle also includes the space taken by the component. There is no use of placing a component in an area where it will clash with other components.

Other definitions

With the above elements of FMDI defined, a component could almost be fabricated, bought, installed and perform its function. There are other definitions concerning a component that are necessary to make the engineering and design process around the components manageable. A lot of people will argue that without the additional definitions (such as certificates) the component can still not be bought or installed, these people are absolutely right. Also during a project execution for example one needs to establish:

- Who is responsible for the component (design, procurement, installation, etc.)
- When is he/she going to execute the actions
- What does it cost

These are the so-called 3W's during project execution. There are more of these sets concerning a component to describe or define the full lifecycle of a component, but they are function or action related and should therefor be handled separately from the FMDI principle. The intention of the FMDI principle is to document the *bare-bone* data to define the component and the component being suitable for its ultimate purpose. This purpose is to perform its function in a process plant.

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Further development of execution principles

The FMDI principle is not the overall solution how to handle data and manage projects in the process industry. However it does provide a mind-set that enables the participants and the stakeholders in a project execution phase to look in a structured way to the work progress based on data and identify possible risk areas. For example if the project is in the construction phase, a function that is not fully defined for a pump filter can have serious consequences later in the project. If the filter can not be purchased maybe the pump has to change and so forth.

Further project execution development related to the FMDI principle could contain subjects as:

- Responsibility assignment: during project execution assign individuals to separate FMDI parts of components or packages. For example process wetted components: function and material responsibility by the process discipline, dimension and interface initiated by engineering
- Simplification of project progress measurement: for each component (or bulk of components) establish a weight factor and assign 30% for the function, 15% for the material, 35% for the dimension and 20% for the interface.
- Change order management, impacts of changes in a project due to inside or outside parties are difficult to assess. One could argue that a change in the function of a component has a larger impact than the change in the dimension. The FMDI principle provides a reasonable basis for discussing and assessing changes.

FMDI in Red-Bag vision for project data handling

The FMDI principle is used by Red-Bag to establish a philosophy for the minimum required data to define a component in a process plant. As a software development company it is necessary to have a clear picture about data and how it should be handled. Like engineers or plant owners, we would like to enter data only once in the system and store it in such a way that we can always quickly access the required information. It does not require much explanation that not all data should be handled the same way. For example: a welders certificate needs to be stored as a document in a document handling database, the flow rate and composition of an offshore oil platform needs to be shown real time on a computer terminal and is probably fed directly in the company's ERP system.

The automated handling of process plant data is to be assessed carefully for the intended purpose and should be related to the full lifecycle of the plant.

The Red-Bag vision on plant data is handled in a separate paper 'Data handling for process plants'.

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